

GeoTide Analyzer



GeoTide Analyzer User Guide

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Document: GeoTide Analyzer User Manual

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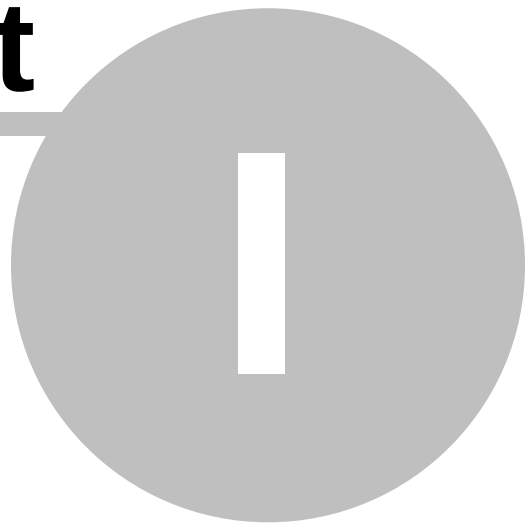
Table of Contents

Part I Overview	8
1 Facilities	8
2 Running	9
3 Panels	10
4 Default Folders	10
5 Analysis and Prediction in 10 steps	12
6 Stages in	13
Importing	13
Saving	15
Loading	15
Editing	15
Analysing	16
Reporting	17
Predicting	17
Making a Spectrum	18
Part II Main Screen	20
1 Menus	20
File	21
Data	22
View	23
Analyse	24
Predict	24
Spectrum	24
Report	24
Tools	25
Help	25
Exit	26
2 Graph Operation	27
Deleting Points	28
Zooming	29
Resizing	30
Scrolling	31
Plotting	31
Graphic Settings	32
Part III Importing Data	36
1 Tidal Height	37
2 1D Stream	40
3 1D Stream: Steps	41
4 2D Stream	43
5 2D Stream: Steps	44

Part IV Editing Data	48
1 Sample	48
2 Average	49
3 Filter	50
4 Manual	52
5 Undo	52
6 Revert	53
Part V Harmonic Analysis	56
1 Selecting a tidal scheme	56
2 Solve By	57
Matrix Inversion	57
Iteration	59
Iteration Options.....	60
Shallow Water Coefficients	61
Analyzing.....	62
3 Saving Harmonic Constants	63
Part VI Predicting	66
1 Comparing Predicted & Observed	67
2 Tide at regular intervals	68
Part VII Reporting	70
1 Functional Overview	70
2 Loading Data	71
3 Comparison Options	71
4 Harmonic Options	72
5 Generating	73
6 Saving	73
Part VIII Tools	76
1 Port Editor	76
Record File	77
Constants File	78
2 Encrypter	79
3 Merge Tool	80
4 Exceedance Tables	81
Part IX Spectrum Analyser	84
1 Functional Overview	84
2 Tool Icons	85
3 Missing Scheme Constituents	86

4	Redundant Scheme Constituents	87
5	Sampling Issues	87
6	Resolution Issues	87
7	Meteorological Tides	88
8	Display Settings - Parameters	89
9	Display Settings - Data Windows	90
10	More on Data Windows	90
Part X Logs, Schemes & Constants		94
1	Original Log	95
2	Working Log	95
3	Analysis Scheme	96
4	Analysis Constants	96
5	Prediction Scheme	97
6	Prediction Constants	97
Part XI Creating a 2D Stream		100
1	Merging 1D streams	100
Part XII Harmonic Tidal Theory		104
1	Tidal Schemes	104
2	Tidal Groups	104
3	Shallow Water Coefficients	105
4	More on Schemes	105
5	Meteorological Effects	106
6	Statistical Accuracy	107
Index		109

Part



Overview

1 Overview

GeoTide Analyzer carries out harmonic tidal constituent analysis, and is designed for the professional hydrographer and tidal surveyor.

GeoTide Analyzer converts observed tide gauge data directly into tidal harmonic constants which can then be used to make tidal predictions for any future or past date.

To create the tidal harmonic constants you need good quality tide gauge data. Your tide gauge data is imported into the GeoTide system using the comprehensive data import facilities, these facilities enable you to select the relevant data fields from the import file data. The import data can also be imported from a text editor or from a spreadsheet such as Microsoft Excel.

In certain rare cases, for example where the tide gauge output is in binary, we can provide additional conversion routines.

Once imported, the tidal data can be edited and filtered using the comprehensive facilities provided within GeoTide to remove spikes and erroneous points.

The user can then select from various options which set the number and type of harmonic constants to be found.

Advanced users can even create their own tidal scheme for use with **GeoTide Analyzer**, specifying which tidal components to include.

The analyzer provides analysis facilities for both tidal heights, and tidal streams.

The tidal constants files created by **GeoTide Analyzer** are compatible with GeoTide-Predictor, our premier tidal prediction package which enables you to produce document ready tide tables.

You can also select a scheme which produces harmonic constants which are compatible with the UKHO Simplified Method, UKHO TotalTide Program and the NOAA Tidal Constituents set.

GeoTide Analyzer also incorporates a log of each processing action.

1.1 Facilities

Data Import.

Supports comma delimited & fixed space ASCII formats.

Graphical Data Editor.

Supports scroll, zoom, edit, delete, filter, average and resample.

Tidal Harmonic Analysis

Converts tidal data into Doodson style harmonic constants.

User-Selectable Tidal Schemes

Enables the user to choose from a number of sets of harmonic constituents, for compatibility with UKHO Simplified, TotalTide and NOAA methods.

Tide-tables

Support for creating Tide Table via GeoTide Predictor.

Spectral Analysis

Frequency scanner for identifying tidal harmonic components.

Reporting Facility

Provides a computer generated report of the tidal levels and analysis statistics.

Tidal Exceedance Tables

Generates 3 types of Tidal Exceedance Tables.

Log

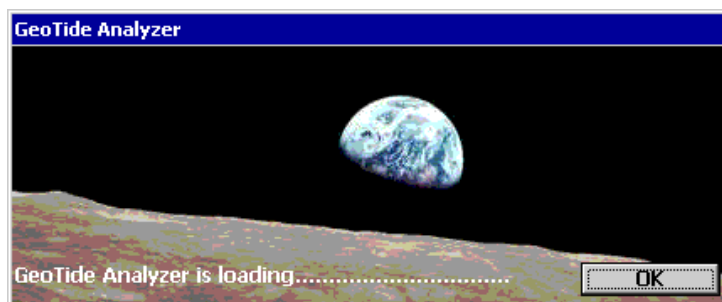
Comprehensive logging of actions for quality audit.

1.2 Running

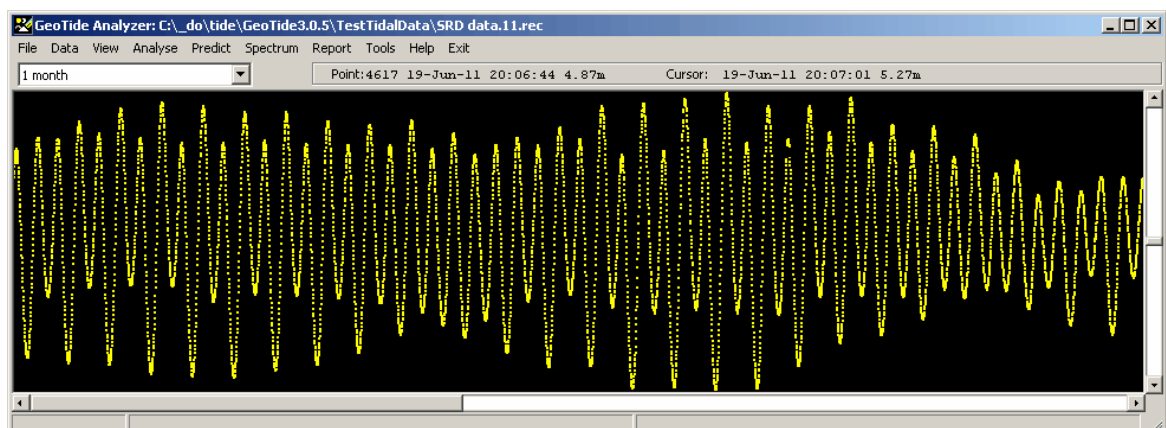
You can run GeoTide either by clicking the icon on the desktop, or by clicking the program shortcut in the **Start>Programs** menu items, or from a file manager such as Microsoft Windows Explorer. Before starting the program please ensure that your hardware security key (dongle) is inserted into a suitable USB port and has been correctly installed.



GeoTide Analyzer first displays the screen below, during which time it allocates memory and loads program modules.



Click OK to display the screen below. This is the main operating window of GeoTide Analyzer.



1.3 Panels

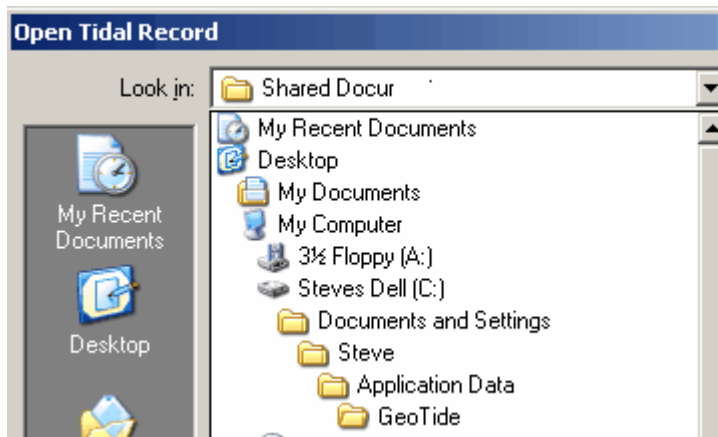
The main windows are listed below.

Window Name	Purpose
GeoTide: Analyzer (Main Screen)	Graphical display of a tidal record
Plot Controller	Sets which plots are displayed.
Sampling	Controls points sampling
Average	Controls points averaging
Filter	Automates the removal of rogue outlying data points
Analysis	Controls the analysis process
Graph Prediction	Controls graph prediction & comparison
Import: Height	Field selection & importing height
Import: 1D Stream	Field selection & importing stream speed only
Import: 2D Stream	Field selection & import of stream speed & bearing
Create 2D Stream	Combining 1D location constants
Graphic Settings	Sets the appearance of the graph points.
GeoTide: Prism	Spectral analysis of tidal source data
Report	Creates a report of tidal parameters & prediction accuracy.

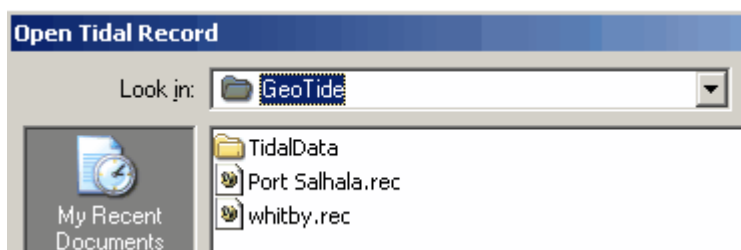
1.4 Default Folders

In line with Microsoft Windows Guidance Notes GeoTide separates the application folder from the user's data and configuration data.

Upon installation GeoTide uses the %APPDATA% environment variable to determine the user's roaming data folder. This folder is used as the default for file selection in the file open and file save as dialogue boxes. Depending upon your system setup this GeoTide folder normally appears in a similar way to that shown below. The folder GeoTide is used as the default folder for most saving and loading operations.



When harmonic constants have been produced (.tc1 files) the user should save the files to the folder GeoTide (located at: %APPDATA%\GeoTide) or to its sub-folder TidalData (i.e. located at %APPDATA%\GeoTide\TidalData) as shown below.



User Data

Tidal Record Files (.rec)

Folder: %APPDATA%\GeoTide

Analyzer Report Files (.rtf)

Folder: %APPDATA%\GeoTide

Harmonic Constants (.tc1)

Folder: %APPDATA%\GeoTide or %APPDATA%\GeoTide\TidalData

Note: Files within %APPDATA%\GeoTide\TidalData are automatically displayed by the Predictor within its location display panel for ease of selection.

Configuration Data

The following locations are used to store configuration settings.

Analyzer Configuration Data (.cfg)

Initial Folder: %APPDATA%\Analyzer

Predictor Configuration Data (.cfg)

Initial Folder: %APPDATA%\Predictor

1.5 Analysis and Prediction in 10 steps

Run Analyzer.EXE

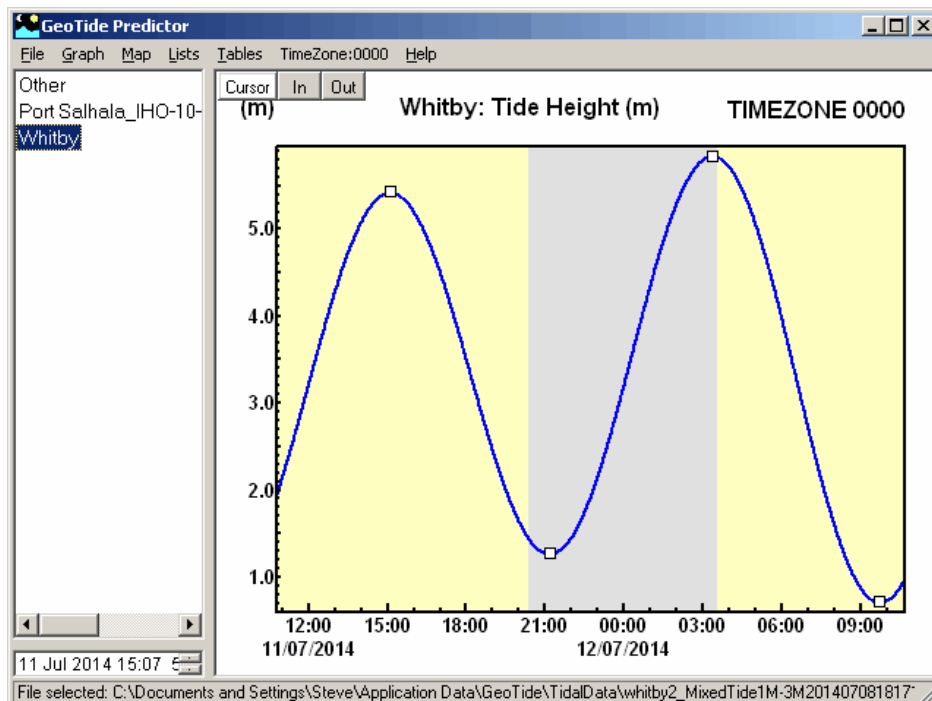
1. Click and load example file by using File|Load "whitby.rec"
2. Click Analyze|Select Scheme "Mixed Tide 1M-3M.sch"
3. Click Solve By: Matrix Inversion
4. Click Analyse. GeoTide displays RMSE 6.3mm
5. Click Close
6. Click File|Save location constants. The dialogue should prompt you with a name and location. Click Save.
- 7 Click Exit on the main window to close the analyzer.

Run Predictor.exe

8. Click File | Open
9. Select the .tc1 file which you just created above
10. It loads as Whitby Harbour and then draw the graph shown below.

Notes

You can drag the graph left or right or zoom in and out as you wish.
You can use the graph menu option to change the date and duration.



Congratulations - you have successfully carried out a harmonic tidal analysis and you used the results to make predictions!

1.6 Stages in

An overview of the basic steps required for carrying out tidal analysis and prediction are:-

- **Importing**

Use the File>Import>Height menu to import an ASCII tidal height file.

-

- **Saving**

Use the File>Save menu to save a tidal data file.

-

- **Loading**

Use the File>Load menu to load a data file which has previously been saved.

-

- **Editing**

Optionally manually edit or filter the data points as required.

-

- **Analysing**

Select the tidal scheme and then carry out the tidal analysis.

-

- **Predicting**

Click the Predict menu option button.

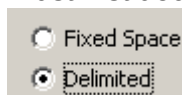
More details are provided on each step in the following pages.

1.6.1 Importing

To import a tidal record in ASCII format click the **File>Import>Depth** menu to load and select a tidal data file. Data files which have been created in a fixed space or comma delimited ASCII file can be imported, provided there is one complete date and height on each record. To import the data the following steps are required.

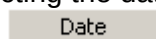
Steps

1. You must first decide whether the source data is fixed space or delimited.



Fixed space data appears in regular columns, whereas delimited data uses a character, usually a comma or tab to separate the data fields. Click the radio button to select the appropriate option for your data.

2. Selecting the data fields.



Click the button marked **Date** and highlight with the mouse the first occurrence of the date field within the data as shown.

Import: Height C:_do\tide\GeoTide3.0.5\whitby.txt

Tide Gauge Data
 Date 01/01/1995
 Duration 100 days
 Location Whitby Harbour
 Time Zone UT

01-Jan-1995 00:00, 2.62
 01-Jan-1995 00:10, 2.81
 01-Jan-1995 00:20, 3.01

Starting Line 7 C:_do\tide\GeoTide3.0.5\whitby.txt|09 Jun 2014 15:

☐ Fixed Space
☒ Delimited

Field Separator First Point Selected

Date 1 , 01-Jan-1995 00:00

Height

The date information is identified and copied to the first row under the label headed "First Point Selected".

Height

Click the button marked **Height** and highlight with the mouse the first occurrence of the height field within the data as shown.

Import: Height C:_do\tide\GeoTide3.0.5\whitby.txt

Tide Gauge Data
 Date 01/01/1995
 Duration 100 days
 Location Whitby Harbour
 Time Zone UT

01-Jan-1995 00:00, 2.62
 01-Jan-1995 00:10, 2.81
 01-Jan-1995 00:20, 3.01

Starting Line 7 C:_do\tide\GeoTide3.0.5\whitby.txt|09 Jun 2014 15:

☐ Fixed Space
☒ Delimited

Field Separator First Point Selected

Date 1 , 01-Jan-1995 00:00

Height 3 2.62

The height information is identified and copied to the second row under the label headed "First Point Selected".

3. Complete the other fields and click **OK** to import the data.

The data will be transferred to the Main Screen as an active working plot.

Once the data has been imported, you should save the imported tidal record using the File>Save menu option as described on the following page.

For a more detailed description on the operation of the import window and of the Location, Gauge ID and Latitude and Longitude fields please see the section: Importing

Data:Tidal Height

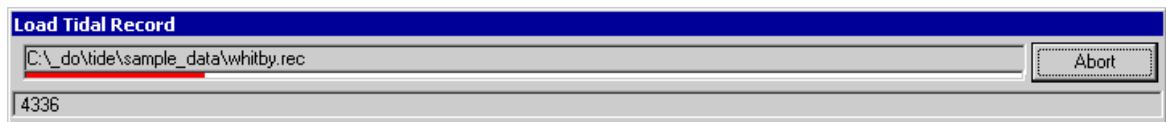
1.6.2 Saving

To save a tidal record click the **File>Save** menu and enter the filename which you want to save. If this file already exists you will be prompted as to whether the file should be overwritten.

The tidal data will be saved in the internal format of GeoTide. Once you have saved a tidal record you can load it at any time to edit it or to carry out a tidal harmonic analysis.

1.6.3 Loading

To load a tidal record click the **File>Load** menu and click the file you want to load. The progress bar below is displayed which shows the extent of the loading process and provides you with the opportunity to cancel the load.



After loading, the tidal record is displayed on the main screen as a graph in both the Original and Working layers. See the Main Screen Section for details on how to use the graphs and how to change their scaling and size.

Note:

Once the tidal data has been imported, you should always use the **File>Load** menu to load the tidal data rather than repeating the import process. This is because GeoTide tidal record files contain an internal audit of all data processing which has been carried out upon or using the file. The files are also directly referenced by the analysis software to maintain a quality audit. Re-importing the data and overwriting these files will overwrite this audit trail.

1.6.4 Editing

GeoTide Analyzer does not require a continuous or regular data set in order to produce an accurate analysis, and missing data or large gaps of even up to a year are not a problem. However, incorrect data such as rogue heights, sometimes known as outliers (appearing as glitches or spikes), or points returning a fixed value (appearing as a horizontal line), will dramatically affect the accuracy and speed at which the Analyzer can establish the harmonic constants.

Alternatively, too many points will slow the analysis process unnecessarily. In this case it is better to sample the record to reduce the data set size.

Manual Edit

You can remove spikes and glitches manually. To do this use the mouse cursor to select the point or points which are known to be incorrect. Then depress the **Delete** key.

Automatic Edit

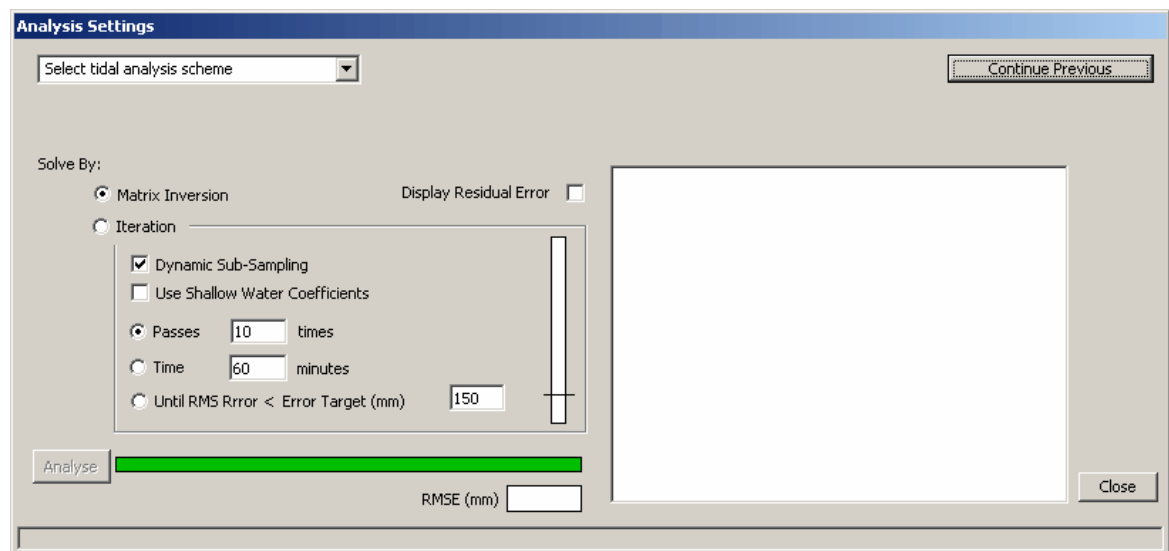
You can automatically remove points by:-

- Averaging neighbouring points. This reduce noise and reduce data set size.
- Sampling at a user defined time interval. This reduces the data set size.

- Filtering. This automatically eliminate rogue data points which are known to have certain characteristics.

1.6.5 Analysing

Display the Analysis Window by clicking the Analysis menu item



Before commencing tidal analysis you must ensure you have loaded a valid tidal record containing good quality data.

Steps

1. Select the tidal analysis scheme which you want to use. The use of different tidal analysis schemes is described in detail in [Selecting a Tidal Scheme](#).
2. Decide on whether you want to use **Matrix Inversion** or **Iteration** methods. **Matrix Inversion** is recommended for all schemes except for the UKHO Simplified Scheme with **Shallow Water Coefficients**.
3. Click the **Analysis** button on the Analysis Window to start the analysis of the tidal data into its separate tidal harmonic components.

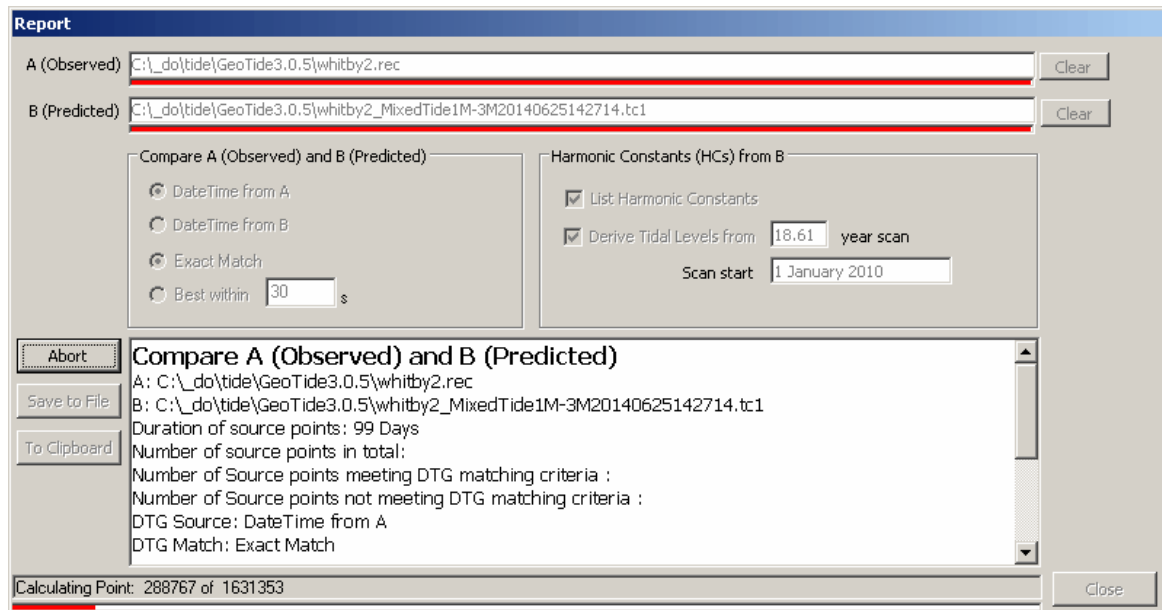
When using Matrix Inversion you will see a series of progress bars indicating conversion.

When using **iteration** you can observe the computed tidal curve changing as it optimally fits the source data. This process can take many minutes or even hours, depending on the accuracy settings, and tide record length, and the tidal scheme chosen. Whilst operating, the error bar will generally decrease showing that the discrepancy between predicted and observed curves is reducing. You can stop the iterative process at any time, or you can wait until it reaches a given value. Once completed or stopped the analysis constants may be viewed and saved.

For a more detailed description on the operation of this window please see the section: [Harmonic Analysis](#).

1.6.6 Reporting

Display the Report Window by clicking the Report menu item.



This window is used to produce a fully formatted report detailing the statistical accuracy of your predictions, the value of tidal levels such as HAT, MSL and LAT and the tidal harmonic constants. The report, suitable for inclusion in technical reports etc, is generated in Rich Text Format (.rtf) and is compatible with most word processors including Microsoft Word.

Steps

1. Click to load an observed (.rec) data file as indicated.
2. Click to load a prediction file as indicated. Normally you would use a tidal constants (.tc1) file to create the predictions for the comparison statistics in your report. However, in some circumstances you may wish to load a second (.rec) tidal record.
3. Click Create Report to create the report. This may take some time. You can save the report to a file or print the report on your printer.

For a more detailed description on the operation of this window please see the section: Reporting.

1.6.7 Predicting

Display the Prediction Window by clicking the Predict menu item.

Steps

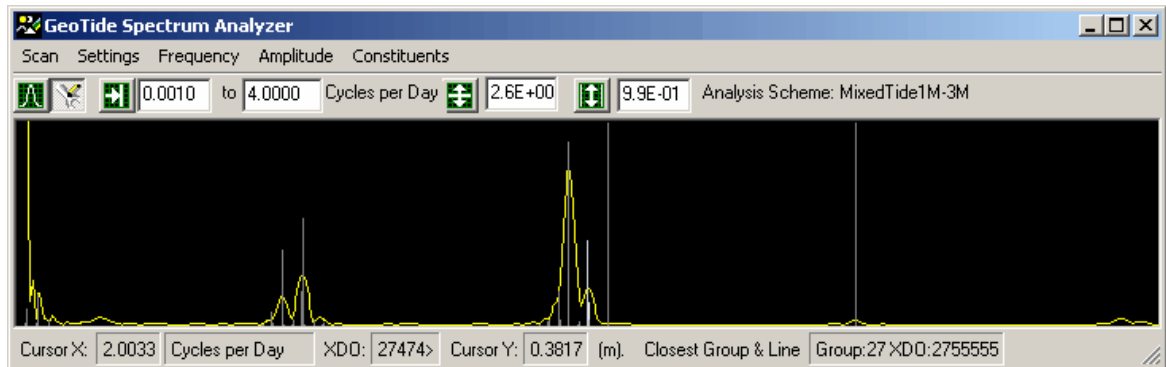
1. Click the tidal constants (.tc1) file which you want to use for predictions
2. Click the options to select the times of the prediction.
3. Click Predict to create the prediction graph - this will be displayed in the Prediction layer on the main screen.

For a more detailed description on the operation of this window please see the section: Prediction.

Both this package, GeoTide Analyzer, and its sister software GeoTide Predictor can

create tidal predictions. Both programs produce identical results since they use exactly the same tidal prediction engine. However, predictions from GeoTide Analyzer should be used for comparison and accuracy checks, while those from GeoTide Predictor should be used for producing formatted output such as tide-tables, and graphs. For help on GeoTide predictor please see the Predictor help file.

1.6.8 Making a Spectrum



Using the Spectrum Analyzer you can create a power spectrum of the tide. The source data for this power spectrum can be the observed tidal curve, the predicted tidal curve, or from the residual (observed - predicted). The steps in creating a tidal spectrum are:

1. Loading a Tidal Record file

Use **File | Load Record** on the main window to load a tidal record. This will be used to create the yellow line on the graph.

2. Loading a Tidal Scheme

The Spectrum Analyser also displays the constituent frequencies of the tidal scheme as vertical lines. Use the top menu '**Analysis**' to click the pull down to load a tidal scheme. This loaded tidal scheme will be used to display the grey and white vertical lines on the graph.

3. Load the Spectrum Analyser

Click the top menu labelled '**Spectrum**' to display the above screen.

4. Creating a Scan

Click Scan or the left icon .

You will see the tidal power spectrum being drawn.

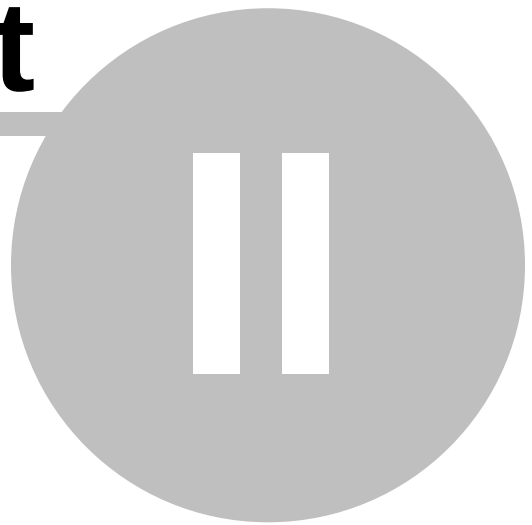
Notes

You can change the Graph Scale by using the Scale Icon . Click this icon and drag the line upwards (with a mouse drag and left click) to make the peaks larger or downwards to make them smaller. Click the icon again to end using this facility.

You can set the Constituent Scale by using the constituent line icon . Click this icon and drag upwards with (with a mouse drag and left click) to make the lines taller or downwards to make them smaller. Click the icon again to end using this facility.

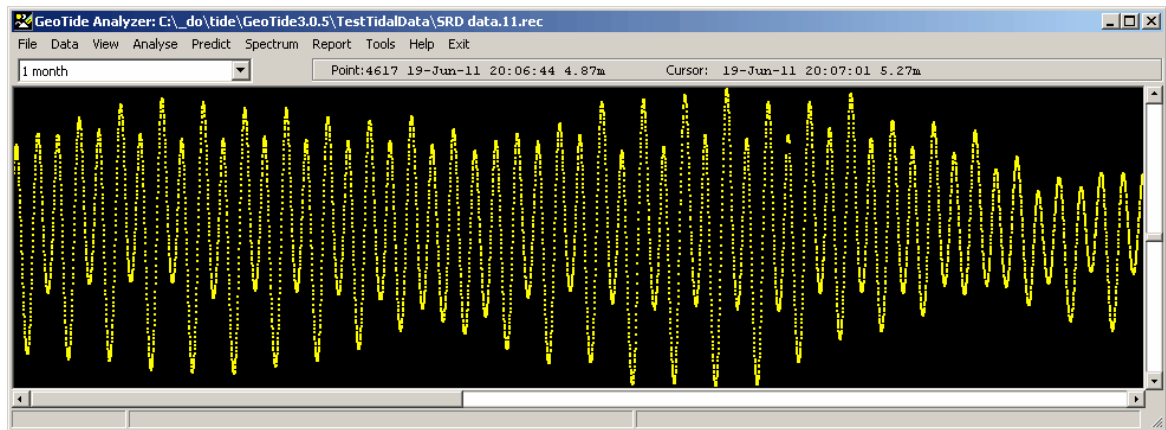
Note that as you move the mouse around the frequency corresponding to the horizontal X value of the mouse pointer is displayed at the lower edge indicate the frequency.

Part



Main Screen

2 Main Screen



The main screen serves as a control center for editing and viewing data as part of data pre-processing, and its main feature is a graphical display, with up to four layers of graphs available. When a tidal record is loaded it is always displayed graphically in this window. Tidal analysis is also initiated from this main windows using the Analyse top-menu function.

The screen can simultaneously display four layers, these are the original graph, the locally edited graph, the results of the tidal analysis curve, and a prediction curve, all in different user selectable colours. The layers may be turned on and off using the "Plot Controller" which is also activated under the View top-menu function.

The vertical axis scale and origin is normally automatically set, while the horizontal axis (timescale) of the window can be set either manually or automatically. The horizontal axis origin is determined by the horizontal scroll bar.

Cursor and point readouts are provided.

2.1 Menus



The top level menu items, shown above, are:-

- **File**

Used to load, import or save data files, harmonic constants or to change settings.

- **Data**

Click Edit to remove or modify source data or to carry out an Undo command.

- **View**

Used to display logs, schemes and harmonic constants.

- **Analyse**

Activates the Tidal Analysis window which carries out harmonic tidal analysis.

- **Predict**

Activates the prediction window.

- **Spectrum**

Activates the prediction window.

- **Report**

Activates the prediction window.

- **Tools**

Activates the Port Header Editor, the Encrypter and the Merge Tool.

- **Help**

Activates the help menu for help related tasks.

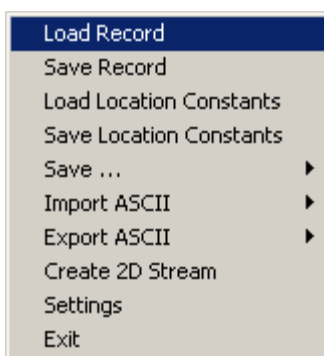
- **Exit**

This is an alternative way of closing the system. If the tidal record or location constants have changed you will be asked if you want to save them.

2.1.1 File



The top level File Menu provides the following sub-menus:-



Load Record

Loads a GeoTide tidal record in file (*.rec)

Save Record

Saves a GeoTide tidal record in file (*.rec)

Load Location Constants

Loads the harmonic constants from a GeoTide tidal constants file (*.tc1)

Save Location Constants

Saves the harmonic constants to a GeoTide tidal constants file (*.tc1)

Save..

Working Layer As
Analysis Layer As
Prediction Layer As

Import ASCII

Depth: Imports records of tidal height data.
1D Stream: Imports records of tidal stream data.
2D Stream: Imports records of tidal stream data to create.

Export ASCII**Original**

Exports this layer as a date/height time series

Working

Exports this layer as a date/height time series

Analysis

Exports this layer as a date/height time series

Prediction

Exports this layer as a date/height time series

Analysis Constants

Exports the analysis harmonic constants (& log)

Prediction Constants

Exports the prediction harmonic constants (& log)

Create 2D Stream

Combines tidal stream harmonic constants (*.tc1) to produce vector stream prediction constants (.tc2).

Settings

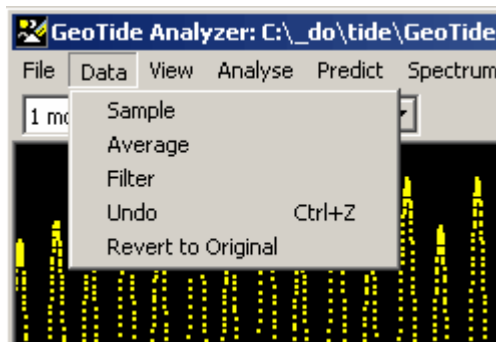
Used to change the main settings, for example to set the colours within the main graph display

Exit

Closes the system. If the tidal record or location constants have changed you will be asked if you want to save them.

2.1.2 Data

The Data menu gains access to the following options.

**Sample**

Enables you to take a subset of points in the tidal record by sampling - this can greatly reduce analysis time. Click "Sample" to display the Sampling window.

Average

Enables you to take a subset of the points in the tidal record by averaging the values of nearby points. This can reduce both noise on the signal and analysis time. Click "Average" to display the Averaging window.

Filter

Enables you to eliminate rogue data points (which are known to have incorrect values) in a semi-automated way.

Undo

"Undo" restores the previously displayed tidal record.

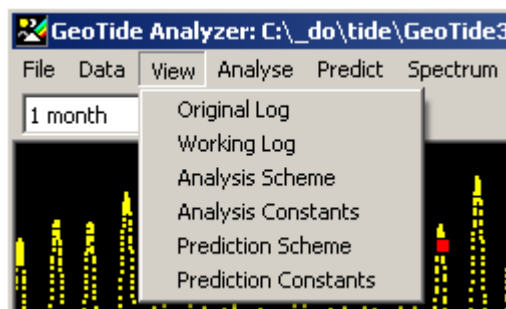
Revert to Original

Reloads the tidal record previously loaded.

2.1.3 View



The View menu gains access to the following options:-



Clicking any option causes the relevant window to be displayed, each having the same overall behaviour, but containing different information relating to the analysis process. Each is a text window, which can be closed by double clicking, and you can cut and paste data from any text window into the clipboard for copying to another application.

However you cannot edit or paste the data to this window..

The text windows displays either

- A log of the editing actions performed on the input data.
- A tidal scheme, i.e. a list of harmonic constants, which were sought when the analysis was carried out.
- Harmonic constants i.e. the list of tidal components (amplitudes & phases) which were determined during an analysis session.

The menu items are:-

Original Log

Displays or hides a Log of all previous actions on data

Active Log

Displays or hides the actions carried out in this session e.g. point deletions

Analysis Scheme

Displays or hides the scheme used in this analysis session

Analysis Constants

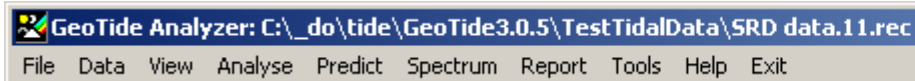
Displays or hides the harmonic constants found in this analysis session

Prediction Scheme

Displays or hides the scheme used for making the prediction constants

Prediction Constants

Displays or hides the harmonic constants found for the location loaded in the prediction window.

2.1.4 Analyse

Click the top menu **Analyse** to display the Analysis Window.

The Analysis Window enables you to analyse the tidal record in the **Working Layer** into its harmonic tidal constants.

Tidal Analysis can only be carried out on the **Working Layer**.

2.1.5 Predict

Click this top menu item to display the Prediction window.

Use this option to make a tidal prediction record from the tidal location constants (*.tc1) in a file.

The prediction record will always be shown in the **Prediction Layer**.

2.1.6 Spectrum

Click the **Spectrum** menu on the top menu item to display the GeoTide tidal Spectral Analyzer.

This facility enables you to analyze your tidal record or the tidal residual (Observed minus Predicted) as a Power Spectrum.

Using a power spectrum you can see the presence of tidal harmonic components in a visual and intuitive way.

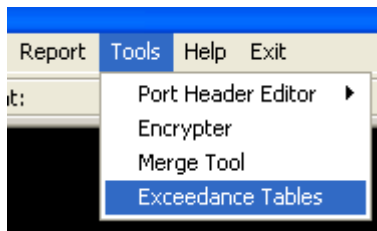
2.1.7 Report

Click the **Report** menu on the top menu item to display the report generator facility.

This enables you to produce a computer generated report containing a comparison of the observed and predicted tidal data, and with a listing of the tidal levels and tidal constituents.

2.1.8 Tools

The Tools Menu provides access to additional facilities which may be present or added to GeoTide.



Port Header Editor

Use this option to change the port details within the record file or tidal constants file.

Encrypter

Use this option to encrypt the tidal constants you have created so that its tidal constants cannot be read by an end- user.

This should be used if you are planning to distribute files along with GeoTide Predictor and if you plan to claim copyright ownership of the harmonic constants which you have created.

Merge Tool

This facility enables you to combine GeoTide Record files.

Exceedance Tables

Generates Tidal Exceedance Tables of 3 different types: High Tide, Maximum Daily, and All Points.

Copyright: Tidal Constants

Geomatix Ltd do not claim ownership of the tidal constants which you create using the tidal analyser within GeoTide.

Copyright: GeoTide Predictor

However we do expect customers to obtain the rights to copy and distribute the GeoTide Predictor program. Please contact us for further details of licensing arrangements for distributing the GeoTide Predictor program to end-users.

2.1.9 Help



The Help menu provides access to the help system and to the Geomatix website.



The options are:-

Find

Opens the help file on the "Find" page

Index

Opens the help file on the "Index" page

Contents

Opens the help file on the "Contents" page

Geomatix Website

Opens a web browser on the Geomatix website

About

Displays version information of this program

2.1.10 Exit

**Closing GeoTide**

To close GeoTide you can clicking the **File | Exit** menu, use the top menu **Exit**, or click the close control button X on upper left hand side of the window. Whichever way is used the termination process is identical.

If, during this session, the settings or data has changed you will be asked if you want to save the changes before quitting the program, so that they are ready for the next time the system is used.

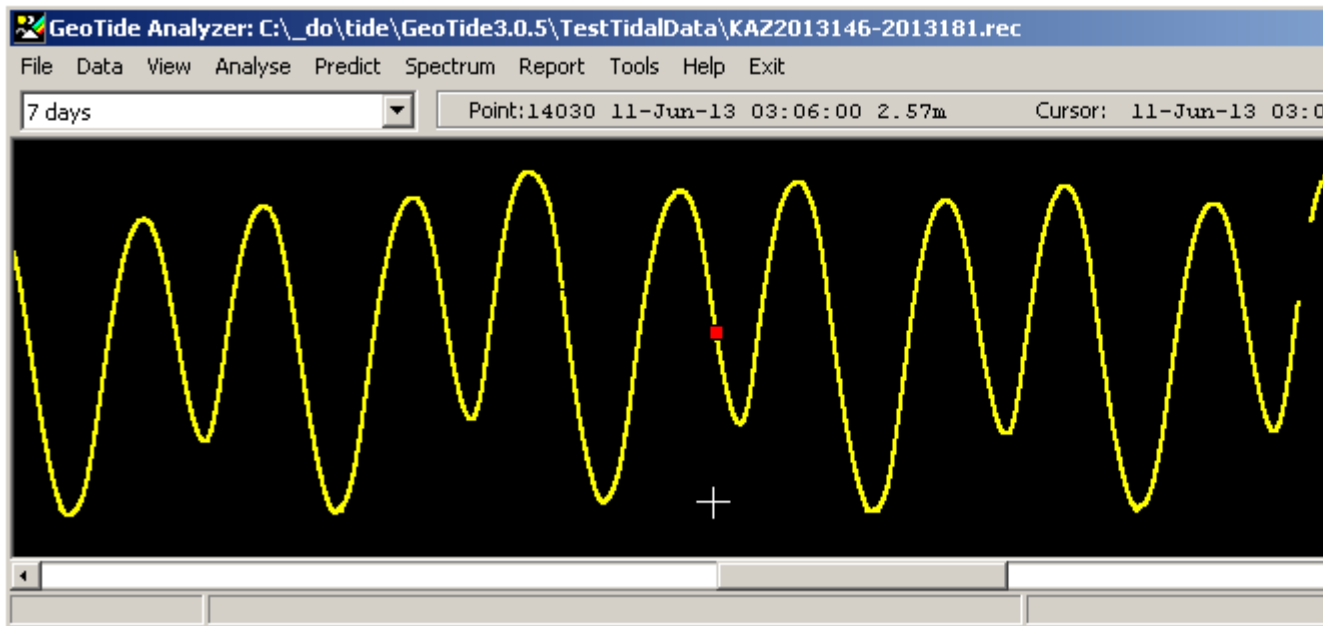
Specifically this applies to the following:-

- changes to the data points within the tidal record
- creation of harmonic constants
- graphic settings for the main screen
- settings for spectrum analyzer

If any of these settings have been changed you will be prompted as to whether you want to save them.

Note You do not need to specify a filename for the system settings configuration.

2.2 Graph Operation



The GeoTide Analyzer main screen displays a tidal curve with a readout of the mouse cursor (as a cross) and a selected 'hopping' point (as a default-red square). As you move the cursor over the graph area the pointer changes to a cross indicating the point readout is active. At the same time, the point with the nearest time value to that of the mouse cursor 'hops' and is continuously highlighted by the square. Note that the cursor position and the selected point values are also displayed as text above the graph. Only one of the four layers can be used as a 'hopping' point readout at a time. The readout layer is set as 'hopping' by clicking the text of the required layer in the Plot Controller window and is called the **active** layer.

Mouse

Delete. Use the left hand mouse key to drag and create a rectangle containing the points you want to delete.

Zoom. Double click the left or right hand mouse keys to zoom in or out.

Keyboard

The shortcut keys are:-

< moves the horizontal scroll bar to the left

> moves the horizontal scroll bar to the right

Delete deletes the currently highlighted point

Home moves the scroll bar to the left showing the start of the graph

End moves the scroll bar to the right showing the end of the graph

F5 redraws the graph.

Window

The main screen can be scaled, resized or scrolled at any time, with the graphs and scaling being automatically adjusted.

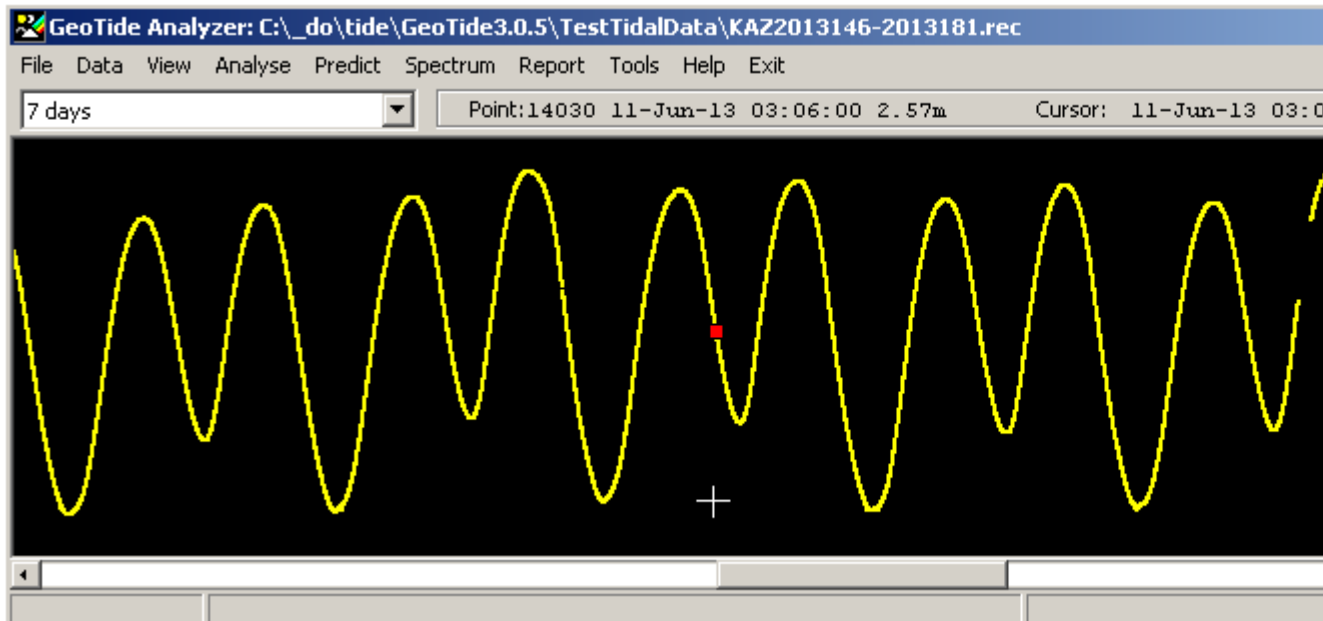
The vertical axis (height scale and origin) of the graph is automatically set for the data. However, the horizontal axis (timescale) of the window can be set either manually or automatically using the pull down list box provided or by using a mouse double click to zoom.

2.2.1 Deleting Points

There are two ways of deleting points within GeoTide.

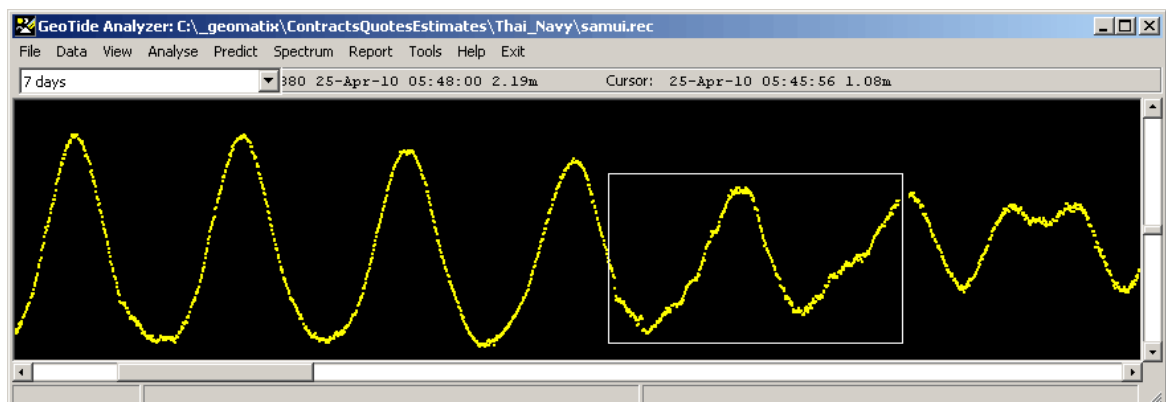
Deleting a single point using the Keyboard.

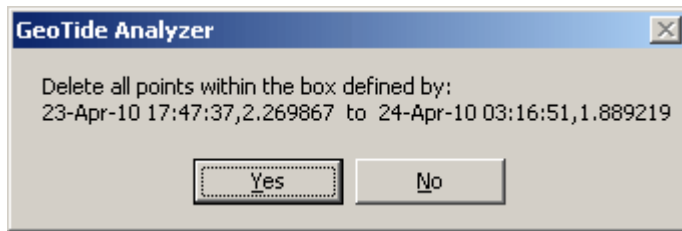
1. Move the mouse cursor over the graph. The nearest point to the mouse cursor is highlighted by a small square which 'hops' along the graph.
2. Use the keyboard 'Delete' key to delete this single highlighted point.



Deleting one or more points using the Mouse.

1. Click and hold down the left hand mouse key and drag the mouse to create a rectangle superimposed upon the graph.
2. Release the mouse key to delete all the points within the rectangle created. You will be prompted to confirm the deletion.



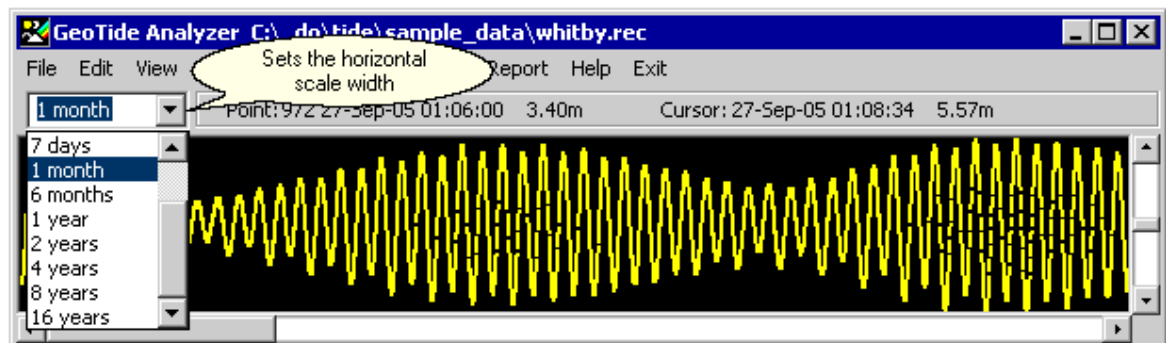


Click yes to delete the points. The operation can generally be undone using the Data | Undo menu.

2.2.2 Zooming

There are two ways of changing the horizontal time scale in GeoTide Analyzer, using the Scale Box, or by using the Mouse.

1. Using the Scale Box



- The horizontal scale can be changed using the mouse buttons or by using the pull down menu.
- The pull down list box on the main screen above sets the horizontal extent of the graph, i.e. the duration from the left hand edge to the right hand edge of the window.
- The options range from 1 hour to 16 years.
- There is also a **fit-to-width** option which always shows the first point at the extreme left and the final point at the extreme right.

2. Using the Mouse

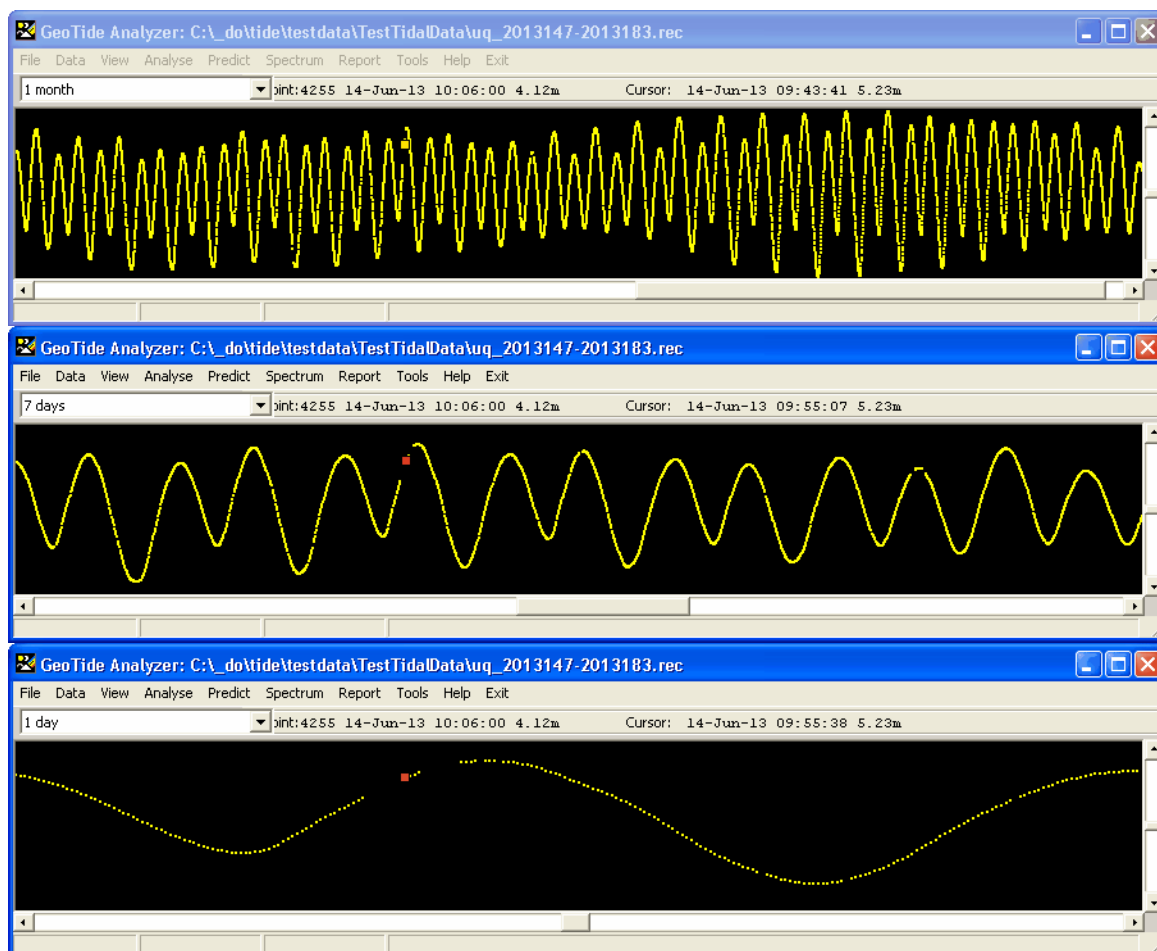
Zooming In

Double click the left mouse button to Zoom-In.

Zooming Out

Double click the right mouse button to Zoom-Out.

An example sequence is shown below.

**Note:**

The horizontal scroll position is automatically adjusted to maintain the on-screen position of the "Hopping Point" wherever possible.

The vertical scale is automatically selected to fit the maximum and minimum values of the tidal records.

2.2.3 Resizing

The main screen can be resized at any time.

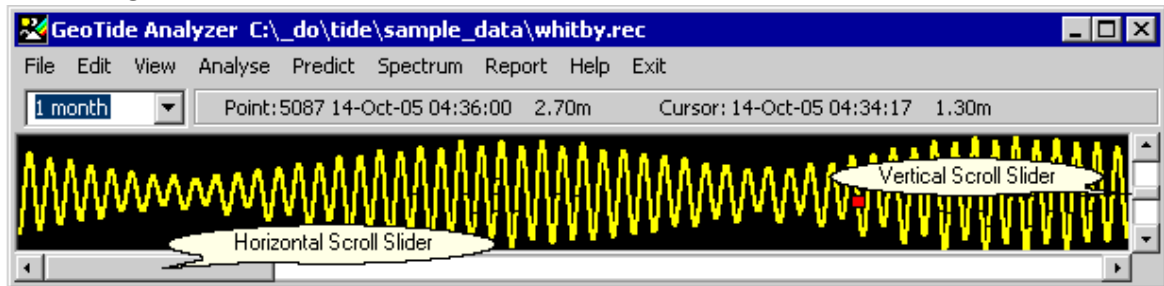
To resize the window move the mouse cursor to any edge or corner of the window and drag as required. The displayed graph(s) will automatically re-scale and both cursor and point readouts will be appropriately adjusted to preserve readout accuracy.

If a large number of data points are loaded (over 1,000,000) you may experience a delay of some seconds (depending on your computer's specification and the size of the tidal record) while the graph(s) are being redrawn. During this short time, you should wait and let the computer carry draw the graph(s), rather than initiating any further processes.

The graphs which are to be redrawn is set in the Plot Controller window. Obviously the more graphs to be redrawn the greater the delay.

Of course, resizing the window will change its physical scale but it will not change its scale relative to the window height.

2.2.4 Scrolling



The main screen can be scrolled at any time, both horizontally and vertically.

Vertical Scrolling

When a file is loaded the vertical window scale is automatically set so that the highest point appears at the upper edge and the smallest at the lower edge. However, you can scroll the vertical scroll bar to offset the plot.

Horizontal Scrolling

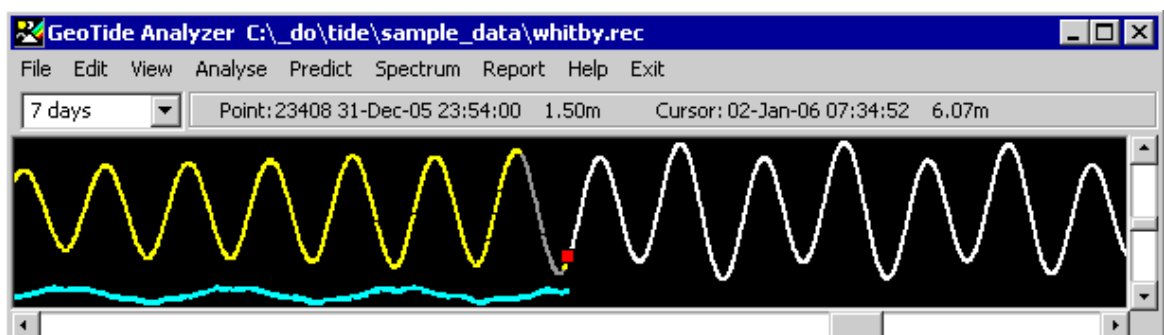
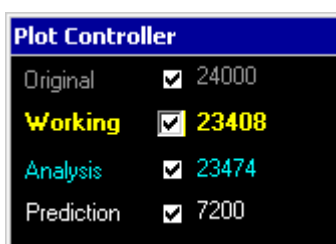
When a file is loaded the horizontal scale is automatically set. You can scroll the graph by using the horizontal scroll slider bar. (Obviously this is not possible when the horizontal scale setting is **Fit-to-Width**.) Clicking the white horizontal scroll area (each side of the slider) moves the graph by around 90% of its width, while clicking the scroll buttons at the lower left and right side of the main window moves the graph by around 25% of its width.

Tip:

When scrolling with the slider bar, the date of the window is shown as the cursor position. When graphs of many years are loaded, this can be a very useful way of finding date regions within a graph.

2.2.5 Plotting

GeoTide Analyzer can hold and plot 4 separate tidal layers simultaneously. The Plot Controller enables you to set which of these 4 records are displayed, and also which of the four are **active**. The **active** layer is the layer in which the Point Cursor (red square) hops from one point to another.



The screenshot shows four layers being displayed simultaneously, the blue line showing the residual error from an analysis rather than a tidal curve.

Check-boxes

Click the check-box, i.e. checking the box, causes that particular graph to be displayed. Unchecking the box causes the graph to be removed from the display i.e. it hides that tidal plot.

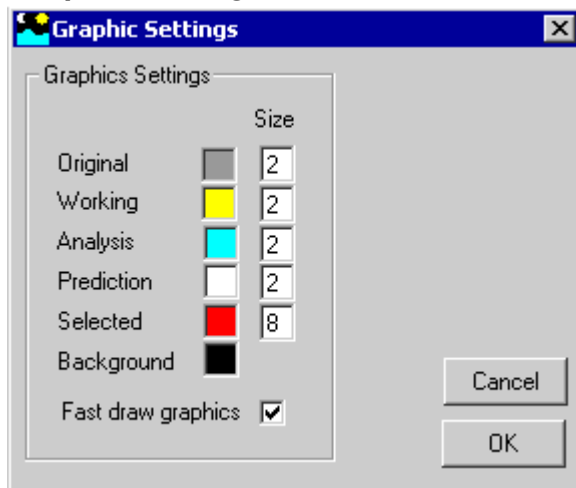
Text

Clicking the actual text (Working, Original, Analysis, Prediction), rather than the checkbox, sets that layer to be **active** i.e. so that the red marker will hop on that layer. When clicked the bold font indicates which layer is the **active** layer.

The number of points within each record is displayed to the right of the checkbox.

The Plot Controller window can be closed using the **View | Plot Controller** menu.

2.2.6 Graphic Settings



Click the **File | Graphic Settings** menu to change the colours and size of drawn points of each layer and the background colour of the main screen. The selected colour and size sets the colour and size of the highlighted point on the **active** layer. Clicking the coloured boxes causes the windows colour selector to be displayed where you should select the new color desired and click OK.

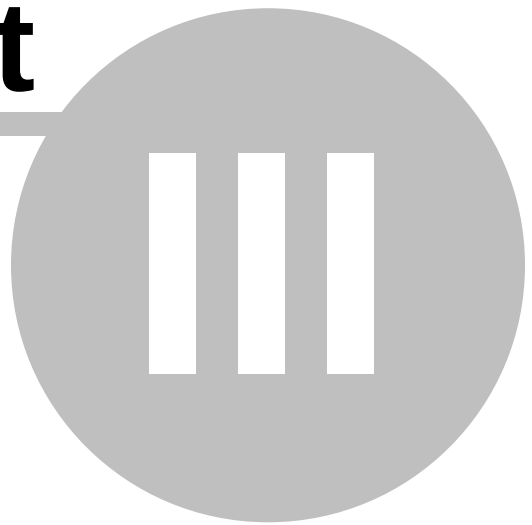


Click the text boxes headed **Size** to change the drawing point size (in pixels)

The option **Fast Draw Graphics** causes a faster set of drawing instructions to be used. This is the recommended setting. The option is provided because very occasionally on extremely regular data with spacing which matches the screen pixel size a resulting moire pattern can be generated which can be distracting.

If the settings have been changed you will be prompted whether you want to save them when you exit the program.

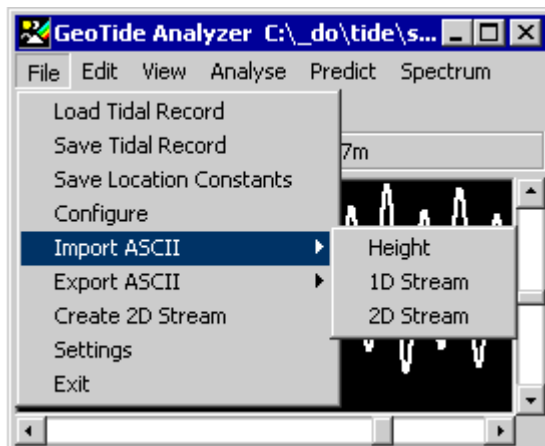
Part



Importing Data

3 Importing Data

Click the **File | Import** menu on the main screen to activate the **Import Options Menu** as shown below.



The input data should be contained in a standard ASCII text file consisting of a series of lines (rows) containing a tidal measurement and a date-time stamp (also known as a date-time group or DTG). The DTG should consist of a text representation of the date and time. Any number of header rows may be present at the top of the file.

Each line must be separated either by the Microsoft Windows separators Carriage-Return (ASCII 13) and Line-Feed (ASCII 10) or Unix Line-Feed (ASCII 10) character. Of course, the line separators are invisible to the user - the text simply appears as a listing in a text editor or word processor.

The options for tidal measurement are as follows:-

Height

Each line should contain a date-time DTG and a value of tidal height (or depth) as a decimal number in meters cms, mm, decimal feet, feet and inches, and fathoms.

1D Stream

Each line should contain a date-time DTG and a value of tidal speed on each line as a decimal number in meters per second, knots, miles per hour, kilometers per hour. For a 1D stream, the heading must, by implication, be the same for all of the points, either because it is

- a) in a known direction, such as in a narrow strait or river, or
- b) a vector component of the tidal flow which has already been applied.

2D Stream

Each line should contain a date-time DTG and a value of tidal speed on each line (as a decimal number in meters per second, knots, miles per hour, kilometers per hour) and a direction (in degrees) on each record. Such a file may have been logged and created using a Doppler Current Profiler (ADCP).

When importing new data into GeoTide Analyzer you are prompted with a warning that the currently loaded records will be overwritten. Clicking **OK** to the warning will bring up the usual File Open Dialogue Box where you should select the file to import and then click "Open". The progress bar below will be displayed.

In the case of 2DStreams you may be given the option of loading the same file again, for taking vector tidal components. This is more fully described in the section entitled

Creating a 2D Stream.

Note: On large files this window will show only the first 32kB of the file. However all of the data file will be processed, even if it is truncated within the display.

3.1 Tidal Height

Import: Height C:_geomatix\ContractsQuotesEstimates\Navionics\Haringvlietsluizen_data.txt

Name: Haringvlietsluizen
 Latitude: 51.8292268352
 Longitude: 4.0448401435
 Unit of measurement: meters

Date	Time	Height
01/01/2012	00:00	0.69
01/01/2012	00:10	0.69
01/01/2012	00:20	0.69
01/01/2012	00:30	0.69
01/01/2012	00:40	0.7

Starting Line: 5 C:_geomatix\ContractsQuotesEstimates\Navionics\Haringvlietsluizen_data.txt [11 Sep 2014 17:18:49]

☐ Fixed Space
☒ Delimited

Field Separator: 1-2 First Point Selected: 01/01/2012 00:00 Additional Correction: 0.0 Hours

Height: 3 Meters (m) 0.0 m ☐ Invert

Gauge ID: Name:Haringvlietsluizen
 Location Name: Haringvlietsluizen
 Time Zone: 0000 *Warning! Use UKHO Notation for Time Zones East is negative, West is positive.

Latitude: 51°49.75'N
 Longitude: 004°02.69'E

Import Cancel OK

Displaying 1431 of 157822 loaded records.

Clicking the **File | Import | Depth** menu (and loading a valid ASCII source data file) displays the **Import: Height** window above. It is used to import data from an ASCII source data into the graphical main window. The purpose of the import window is as follows:

1. Allocate the date and height fields,
2. To enter meta-data such as location,
3. Change the sign / units of the data and add an offset, if required.
4. Load the data into the graphical main window

The content of the ASCII file is shown in the upper portion of the window, with scroll bars to view the file. The steps to importing the ASCII file are:-

1 Setting the Delimited / Fixed Space option

This indicates the type of file you are importing. A delimited file is where there is always the same character as a separator, often a comma or a tab. A fixed space file is one where the data forms perfect columns which do not move to the left or right as you scroll down the file.

2 Setting the Date and Height fields.

The date and height fields are selected by highlighting the first occurrence of the data with the mouse. To highlight the relevant information move the mouse to the left of the information, hold down the left mouse button and move the mouse to the end of the information. Note that the whole field must be highlighted. If it is the last field on the row highlight as far as possible to the right.

a) The Date Field.

Click the Date button and highlight the first row where a date is present. Note that the whole date must be highlighted. Use the pull down checkbox labelled "Regional Settings" to determine the method of date conversion. The options are:-

- (1). **Regional Settings** uses the window regional system setting and routines, or
- (2). **US Date Conversion** using our own internal routines
- (3). **Non US Date Conversion** using our own internal routines.

b) The Height / Depth Field

Click the Height button and highlight the first row where a height or depth is present. Note that the whole date must be highlighted. If the value is a depth, rather than a height, then click the invert button also.

3 Units and Corrections

a) Units

The units available are meter cm, mm, decimal feet, feet and inches and fathoms. The conversion is carried out upon input. GeoTide Analyzer works internally exclusively in meters.

b) Additional Correction to Date

A correction to the data in the time field can be incorporated here. For example if the tide gauge is set to a different time zone from the standard time zone for that location. Enter a figure in decimal hours to add to the time.

c) Additional Correction to Height (CD)

A constant addition can be incorporated to allow for differences in Chart Datum between the gauge and prediction datum required. Enter a figure to add in meters in the text-box "Add(m)".

4 Meta Data

The Gauge ID, Location Name, Time Zone, Latitude and Longitude may also be set by clicking the relevant button and then highlighting the information in a similar way to setting the height and date fields above. We recommend that this data is always entered for audit purposes.

i) Location Name

You can enter the name by typing or by clicking this button and then highlighting the name in the data source window if present.

Note that you can enter here optional non western characters using their html equivalents.

If the western (ASCII) characters are to appear first they must be separated from the non-Western characters by for example as:

Port Salalah مينـاءص
ـلالــه

Or if the Arabic is required first:

مينـاءصـل
الــ&#1607 Port Salalah

ii) Gauge ID

You can enter the Gauge ID by typing or by clicking this button and then highlighting the GaugeID in the data source window if present.

iii) Time Zone

You can enter the time zone manually or by clicking this button and then highlighting the time zone in the data if present.

iv) Latitude

You can enter the Latitude by typing it or by highlighting the latitude in the data source window if present.

Acceptable formats are +/-decimal degrees or dd mm.mm N/S or dd mm ss.ss N/S)

v) Longitude

You can enter the Longitude by typing it or by highlighting the longitude in the data source window if present.

Acceptable formats are +/-decimal degrees or dd mm.mm E/W or dd mm ss.ss E/W)

5 Import Button

To Import the data depressing the Import button. You will see a count of the number of points imported.

The imported points appear as the "Source" layer on the main window.

6 OK Button

Click **OK** to copy this information to the **Working** layer or click.

You can click **Cancel** at any time to abandon the import process.

Note: On large files this window will display only the first 32kB of the file. However all of the data file will be processed, even if it is truncated within the display.

3.2 1D Stream

Clicking the **File | Import | Import1D Stream** menu (and loading an ASCII source data file) displays the **Import: 1D Stream** window.

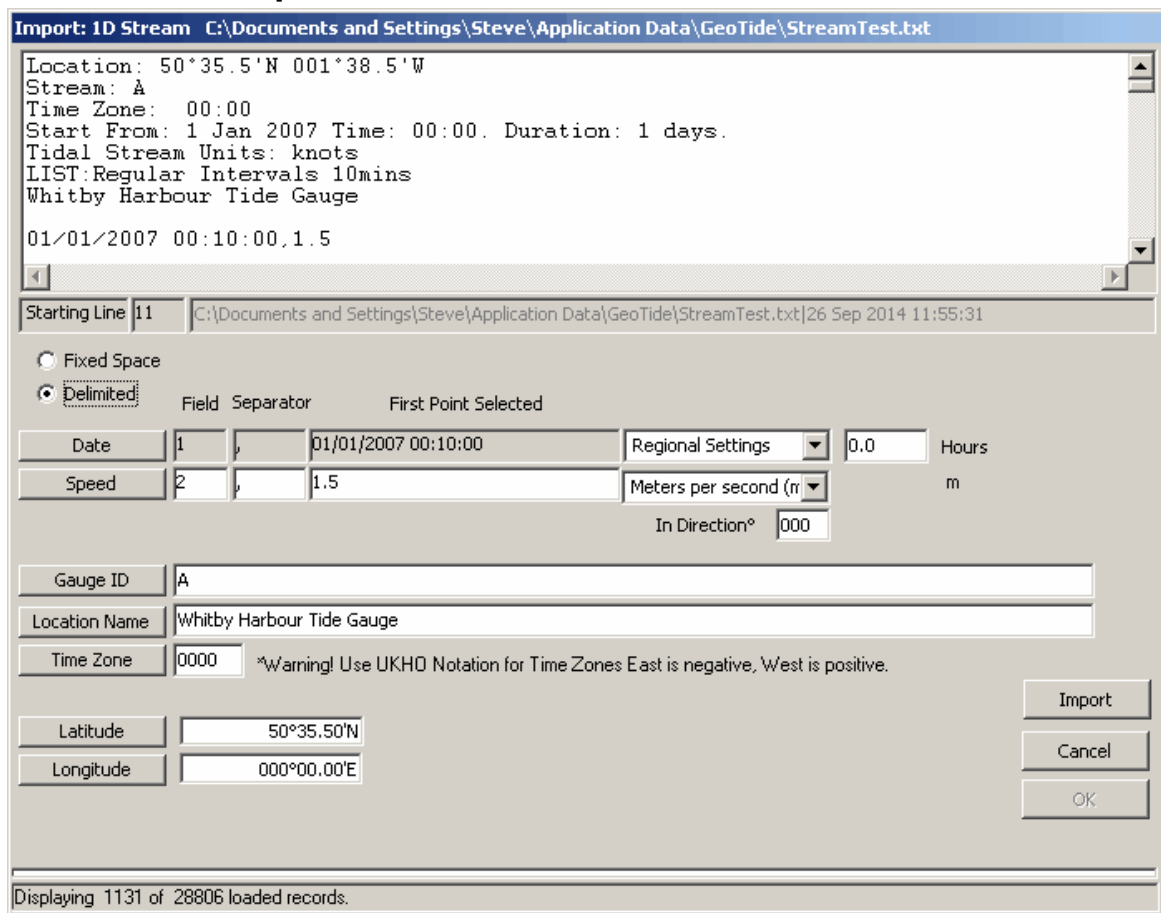
The ASCII file should contain date-time and speed fields on each record. The direction is assumed to be the same throughout the file, either by virtue of its location, e.g. a narrow strait or river, or because it has already been resolved by a 2 component vector tide stream gauge. The content of the ASCII file is shown in the upper portion of the window, with scroll bars to view the file. On large files this window will show only the first 32kB of the file. All of the data file will be processed, even if it is truncated in the display. The purpose of this window is to:

1. Allocate the date and speed fields
2. Convert the speed units
3. Allocate a stream direction to the data
4. Enter Metadata such as location, and position or click/highlight/select as with tidal heights.
5. Load the data into the graphical main window

The steps, which are very similar to those for tidal heights, are described in more detail in the following section.

Note: On large files this window will show only the first 32kB of the file. However all of the data file will be processed, even if it is truncated within the display.

3.3 1D Stream: Steps



Import: 1D Stream C:\Documents and Settings\Steve\Application Data\GeoTide\StreamTest.txt

Location: 50°35.5'N 001°38.5'W
 Stream: A
 Time Zone: 00:00
 Start From: 1 Jan 2007 Time: 00:00. Duration: 1 days.
 Tidal Stream Units: knots
 LIST: Regular Intervals 10mins
 Whitby Harbour Tide Gauge
 01/01/2007 00:10:00,1.5

Starting Line 11 C:\Documents and Settings\Steve\Application Data\GeoTide\StreamTest.txt|26 Sep 2014 11:55:31

☐ Fixed Space
☒ Delimited

Field Separator First Point Selected

Date 1 , 01/01/2007 00:10:00 Regional Settings 0.0 Hours
 Speed 2 , 1.5 Meters per second (m) m
 In Direction° 000

Gauge ID A
 Location Name Whitby Harbour Tide Gauge
 Time Zone 0000 *Warning! Use UKHO Notation for Time Zones East is negative, West is positive.

Latitude 50°35.50'N
 Longitude 000°00.00'E

Import
 Cancel
 OK

Displaying 1131 of 28806 loaded records.

The steps in importing a 1D Stream are:-

1. Setting the Delimited / Fixed Space Option

This indicates the type of file you are importing. A delimited file is where there is always the same character as a separator, often a comma or a tab. A fixed space file is one where the data forms perfect columns which do not move to the left or right as you scroll down the file.

2. Setting the Date and Speed Fields

Select the field by highlighting, i.e. move the mouse while holding the left button down. Note that the whole field must be highlighted. If it is the last field on the row highlight as far as possible to the right.

a) The Date Field

Click the Date button and highlight the first row where a date is present.

b) The Speed Field

Click the Speed button and highlight the first row where a speed is present. Note that this speed must all be in the same direction.

3. Units and Corrections

In Direction

Enter here the known direction of the stream in degrees. This direction is either known because of its geographical shape or location, e.g. a narrow strait or river, or because it has already been resolved, e.g. by a 2 component vector tide stream

gauge.

Units

The units available are Meters per second, knots, miles per hour and kilometres per hour. This conversion to meters per second is carried out upon import. For tidal streams GeoTide Analyzer works exclusively in meters per second.

4. Meta Data

The Gauge ID, Location Name, Time Zone, Latitude and Longitude may also be set by clicking the relevant button and then highlighting the information in a similar way to setting the height and date fields above. We recommend that this data is always entered for audit purposes.

i) Location Name

You can enter the name by typing or by clicking this button and then highlighting the name in the data source window if present.

Note that you can enter here optional non western characters using their html equivalents.

If the western (ASCII) characters are to appear first they must be separated from the non-Western characters by for example as:

Port Salalah مينـاءصـلالــه

Or if the Arabic is required first:

مينـاءصـلالــ&#1607 Port Salalah

ii) Gauge ID

You can enter the Gauge ID by typing or by clicking this button and then highlighting the GaugeID in the data source window if present.

iii) Time Zone

You can enter the time zone manually or by clicking this button and then highlighting the time zone in the data if present.

iv) Latitude

You can enter the Latitude by typing it or by highlighting the latitude in the data source window if present.

Acceptable formats are +/-decimal degrees or dd mm.mm N/S or dd mm ss.ss N/S)

v) Longitude

You can enter the Longitude by typing it or by highlighting the longitude in the data source window if present.

Acceptable formats are +/-decimal degrees or dd mm.mm E/W or dd mm ss.ss E/W)

Import Button

You will see a count of the number of points imported. The imported points appear as the "Source" layer on the main window.

OK Button

Click **OK** to copy this information to the **Working** layer or click.

You can click **Cancel** at any time to abandon the import process.

3.4 2D Stream

Import: 2D Stream C:\Documents and Settings\Steve\Application Data\GeoTide\StreamTest.txt

Location: 54°35.5'N 000°38.5'E
 Stream: ADCP 1
 Time Zone: 00:00
 Start From: 1 Jan 2007 Time: 00:00. Duration: 1 days.
 Tidal Stream Units: knots
 LIST: Regular Intervals 10mins
 Humber Bank Binks
 01/01/2007 00:10:00,1.5,266
 01/01/2007 00:20:00,1.4,265

Starting Line 10 C:\Documents and Settings\Steve\Application Data\GeoTide\StreamTest.txt|26 Sep 2014 11:55:31

☐ Fixed Space
☒ Delimited

	Field	Separator	First Point Selected			
Date	1	,	01/01/2007 00:10:00	Regional Settings	0.0	Hours
Speed	2	,	1.5	Meters per second (m)		m
Heading	3	,	266	In Direction°	000	

Gauge ID ADCP 1

Location Name Humber Bank Binks

Time Zone 0000 *Warning! Use UKHO Notation for Time Zones East is negative, West is positive.

Latitude 54°35.50'N

Longitude 000°00.00'E

Import Cancel OK

Displaying 1131 of 28806 loaded records.

Clicking the **File>Import>Import2D Stream** menu (and loading an ASCII source data file) displays the **Import: 2D Stream** window. The content of the ASCII file is shown in the upper portion of the window, with scroll bars to view the file. The file should contain date-time, speed and heading fields on each record. Its purpose is to:

1. Allocate the date, speed and heading fields
2. Enter Meta Data such as location, and position
3. Take the vector component of the speed and heading records
4. Load the data into the graphical main window

If the file has recently been chosen the data entry areas are not cleared in order to save them all from being re-entered.

The steps, which are similar to those for 1D tidal streams, are described in more detail in the following section.

Note: On large files this window will show only the first 32kB of the file. However all of the data file will be processed, even if it is truncated within the display.

3.5 2D Stream: Steps

Import: 2D Stream C:\Documents and Settings\Steve\Application Data\GeoTide\StreamTest.txt

Location: 54°35.5'N 000°38.5'E
 Stream: ADCP 1
 Time Zone: 00:00
 Start From: 1 Jan 2007 Time: 00:00. Duration: 1 days.
 Tidal Stream Units: knots
 LIST: Regular Intervals 10mins
 Humber Bank Binks
 01/01/2007 00:10:00,1.5,266
 01/01/2007 00:20:00,1.4,265

Starting Line: 10 C:\Documents and Settings\Steve\Application Data\GeoTide\StreamTest.txt|26 Sep 2014 11:55:31

☐ Fixed Space
☒ Delimited

Field Separator: , First Point Selected: 01/01/2007 00:10:00

Field	Separator	First Point Selected	Regional Settings	0.0	Hours
Date	1	01/01/2007 00:10:00	Regional Settings	0.0	Hours
Speed	2	1.5	Meters per second (m)		m
Heading	3	266	In Direction°	000	

Gauge ID: ADCP 1
 Location Name: Humber Bank Binks
 Time Zone: 0000 *Warning! Use UKHO Notation for Time Zones East is negative, West is positive.

Latitude: 54°35.50'N
 Longitude: 000°00.00'E

Import Cancel OK

Displaying 1131 of 28806 loaded records.

The steps in importing a 1D Stream are:-

1. Setting the Delimited / Fixed Space Option

This indicates the type of file you are importing. A delimited file is where there is always the same character as a separator, often a comma or a tab. A fixed space file is one where the data forms perfect columns which do not move to the left or right as you scroll down the file.

2. Setting the Date and Speed Fields

Select the field by highlighting, i.e. move the mouse while holding the left button down. Note that the whole field must be highlighted. If it is the last field on the row highlight as far as possible to the right.

a) The Date Field

Click the Date button and highlight the first row where a date is present.

b) The Speed Field

Click the Speed button and highlight the first row where a speed is present. Note that this speed must all be in the same direction.

c) The Heading Field

Click the Speed button and highlight the first row where a heading is present.

3. Units and Corrections

In Direction

Enter here the direction in which to resolve the stream in degrees. The speed and direction recorded in the file will be resolved to form a new component in this direction. When carrying out a 2D stream analysis the import process is repeated for each of the two components. It is important to specify the two directions as orthogonal i.e. 90 degrees apart. See Creating a 2D Stream

Units

The units available are Meters per second, knots, miles per hour and kilometres per hour. This conversion to meters per second is carried out upon import. For tidal streams GeoTide Analyzer works exclusively in meters per second.

4. Meta Data

The Gauge ID, Location Name, Time Zone, Latitude and Longitude may also be set by clicking the relevant button and then highlighting the information in a similar way to setting the height and date fields above. We recommend that this data is always entered for audit purposes.

i) Location Name

You can enter the name by typing or by clicking this button and then highlighting the name in the data source window if present.

Note that you can enter here optional non western characters using their html equivalents.

If the western (ASCII) characters are to appear first they must be separated from the non-Western characters by for example as:

Port Salalah مينـاءصـلالــه

Or if the Arabic is required first:

مينـاءصـلالــ&#1607 Port Salalah

ii) Gauge ID

You can enter the Gauge ID by typing or by clicking this button and then highlighting the GaugeID in the data source window if present.

iii) Time Zone

You can enter the time zone manually or by clicking this button and then highlighting the time zone in the data if present.

iv) Latitude

You can enter the Latitude by typing it or by highlighting the latitude in the data source window if present.

Acceptable formats are +/-decimal degrees or dd mm.mm N/S or dd mm ss.ss N/S)

v) Longitude

You can enter the Longitude by typing it or by highlighting the longitude in the data source window if present.

Acceptable formats are +/-decimal degrees or dd mm.mm E/W or dd mm ss.ss E/W)

Import Button

You will see a count of the number of points imported. The imported points appear as the "Source" layer on the main window.

OK Button

Click **OK** to copy this information to the **Working** layer or click.

You can click **Cancel** at any time to abandon the import process.

Part



IV

Editing Data

4 Editing Data

Editing data is a most important part of the overall tidal analysis process, since erroneous data points can slow the analysis convergence and lead to inaccurate harmonic constants.

Unlike some packages, **GeoTide Analyzer** does not require a tidal record at regular time intervals to produce an accurate analysis, and missing data or large gaps in the record are not a problem to the analysis system - provided they do not occupy a significant portion of the total duration and the gaps themselves do not occur at regular intervals

However, any incorrect heights within the tidal record will severely limit the accuracy of the analysis process and will considerably increase the time required for a satisfactory iteration. Such erroneous points often appear as glitches or spikes within a tidal record or as blocks of identical incorrect values. We strongly recommend that each record is carefully examined and that such points are removed prior to its use for iteration. The cause of such incorrect points can be various - including instrumentation errors, data transmission errors, keyboard errors, unusual weather or simply flotsam jamming a tidal sensor.

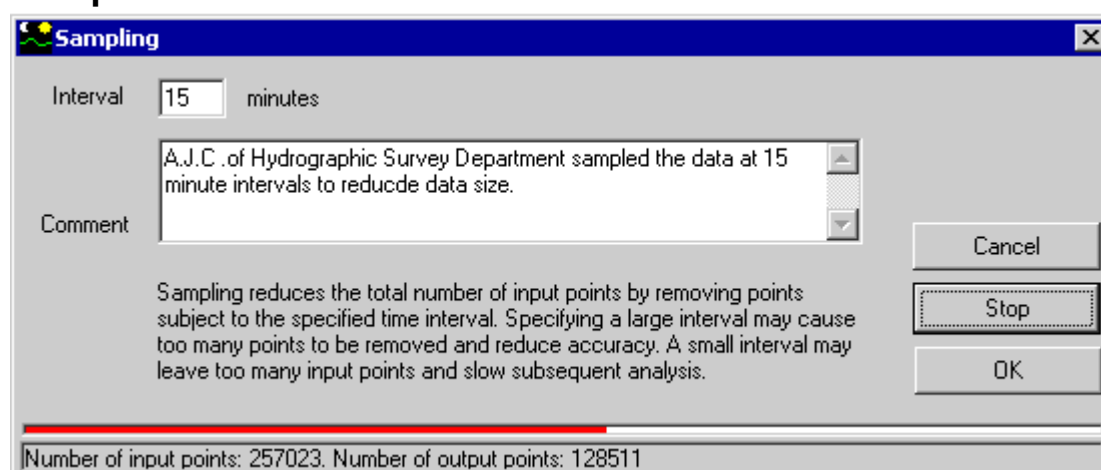
As many as possible incorrect points should be removed prior to analysis. The old adage from Cartography applies very much here: *"When in doubt - leave it out!"*

GeoTide Analyzer provides both automatic and manual editing facilities for the removal of such points.

The main **Edit** menu provides access to automatic editing (as sampling, averaging, and filtering), while the main screen and mouse provide manual edit facilities.

This section describes these methods of editing data in detail.

4.1 Sample



Click **Edit>Sample** on the main screen to display this window.

Sampling reduces the number of points by removing points from the working layer, subject to the time interval provided in the text box. Specifying too large a time interval may reduce accuracy, while specifying too small an interval may leave too many points in the record and unnecessarily slow the tidal analysis. GeoTide Analyzer will typically analyse records with between 5,000 to 500,000 points. The active elements are:-

Interval

This is the minimum time interval between the output data points.

Sample

Click to carry out the sampling process

Cancel

Click to abandon the sampling carried out and restore the plot to the state before this window was displayed

OK

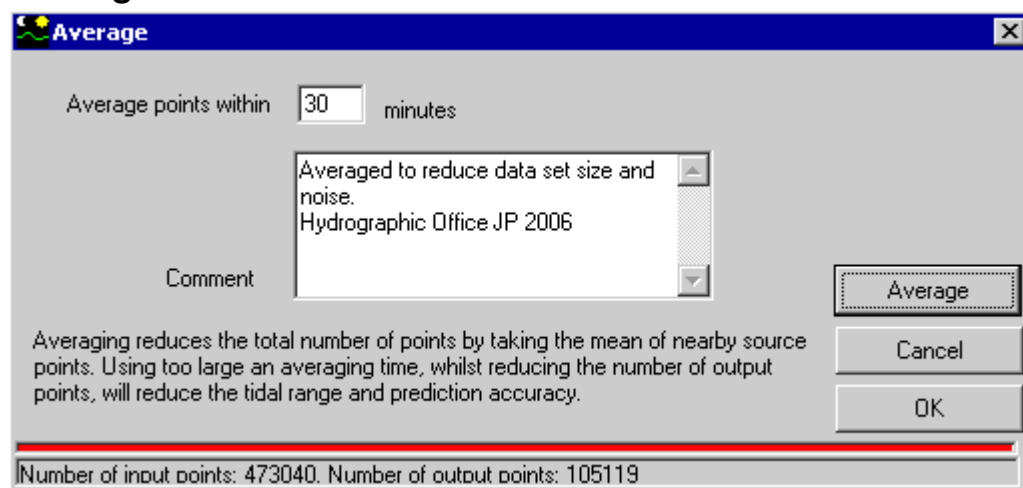
Click to accept the sampling already done and to enter it into the main window.

Comment

You can optionally enter any comment, such as your reasons for carrying out this sampling action, into the comment text-box.

Note: GeoTide Analyzer keeps a log of all sampling actions.

4.2 Average



Click the menu **Edit>Average** on the main screen to display this window.

Averaging reduces the total number of points, taking the mean of nearby source points which are within a time averaging window. The width of the time averaging window is user specifiable. Averaging should be used in preference to sampling, where there is a random noise on the signal. Using too large an averaging time, however, whilst reducing the number of output points, will also reduce the tidal range and prediction accuracy. GeoTide Analyzer will typically analyse records with between 5,000 to 100,000 points, depending upon accuracy and tidal scheme selected. The active elements are:-

Interval

This is the minimum time interval between the output data points. Points within the window are averaged, both in terms of height and time, to create a new data point.

Average

Click to carry out the averaging process.

Cancel

Click to abandon the averaging carried out and restore the plot to the state before this

window was displayed.

OK

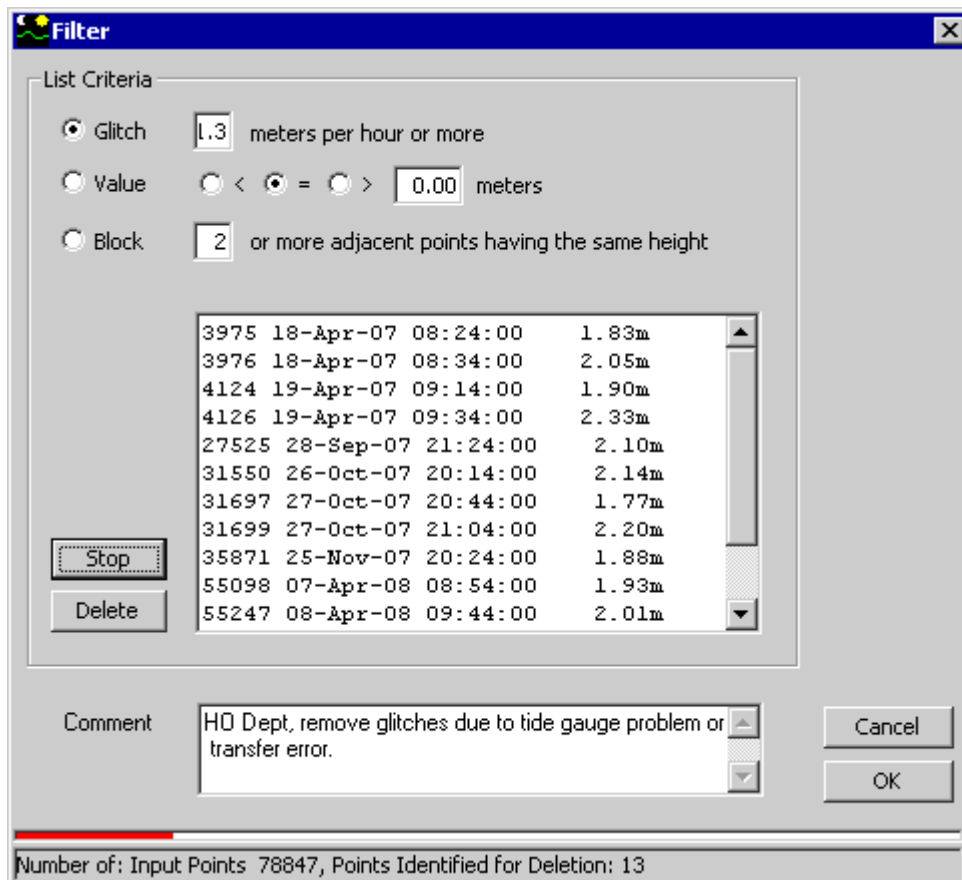
Click to accept the averaging already done and to enter it into the main window.

Comment

You can optionally enter any comment (such as reasons for carrying out this averaging action) into the comment text-box.

Note: GeoTide Analyzer keeps a log of all sampling actions. The settings are internally saved, along with any comment.

4.3 Filter



Click the main menu item **Edit>Filter** to display this window. Filtering is used to remove incorrect data points which due their characteristic values are known to be incorrect. Filtering is a two stage process. Firstly the points are identified and listed for filtering according to the criteria which you have specified. Secondly, the listed points are deleted from the record by clicking the **Delete** button. At any point you can abandon the search for points by clicking the **List / Stop** button. You can filter by **Glitch**, by **Value** or by **Block**.

By Glitch

A glitch is characterised by the slope of the graph between that point and its following neighbour. Depending on the tidal range, a typical figure of greater than 4 meters per hour almost certainly indicates an erroneous data point. The glitch search is triggered by a positive or a negative slope which exceeds the value set.

By Value

Filtering by value enables you to remove points according to their value. Points which are equal to, greater than, or less than a certain value can be automatically listed for removal. This is useful since in many cases certain values or range of values are known to be incorrect. For example when some tide gauges fail a figure of 99 is always returned and if there is a data transmission or electrical problem, frequently the value stored is 0, or a figure which is below the lowest astronomical tide is returned if a tide gauge jams. Such values can be removed automatically using this facility.

By Block

Data may be returned where blocks of adjacent points have identical values. Such problems can occur due to equipment failure. Of course it is possible, depending upon the time interval, that at high and low tide a few adjacent values will be identical. For this reason you can set a figure for the minimum number of identical adjacent values which will trigger this filter.

Note: Care should be exercised when using this filter facility not to remove valid data.

The active buttons are:-

List

This button initiates the filtering process. When in progress, its caption changes to **Stop** to allow you to abandon a filtering action which is too time consuming or inappropriate. Resetting the listing options clears the list and the points will not have been deleted. You must explicitly click the Delete button (below) to delete the points listed.

Delete

Deletes all of the listed points identified in the deletion list.

Cancel

Click to abandon the filtering carried out and restore the plot to the state before this window was displayed. Any comments entered will not be stored.

OK

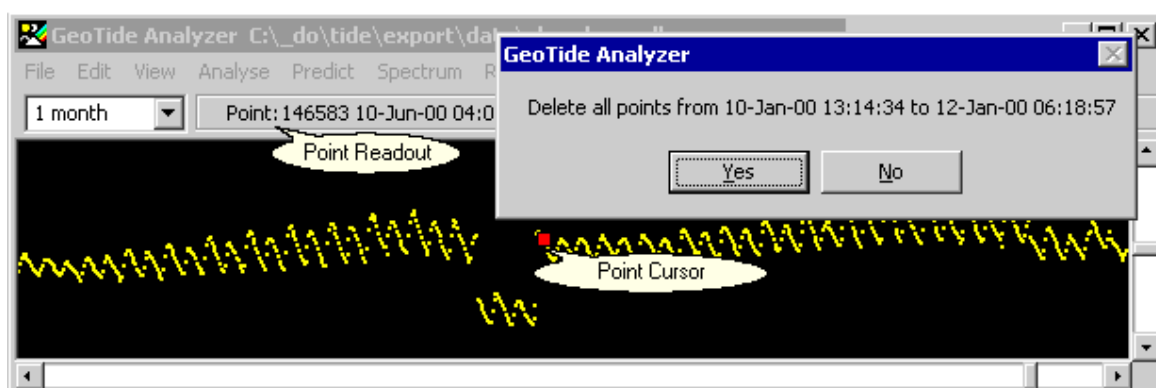
Click to accept the filtering already done and to enter it into the main window. Any comments will also be stored.

Comment

You can optionally enter any comment which will be stored regarding this filtering action..

Note: GeoTide Analyzer keeps a log of all filtering actions. The settings are internally saved, along with any comment.

4.4 Manual



The Point Cursor

As you move the normal cursor across the window a small red square, known as the point cursor hops from one point to the next. This arrangement enables you to easily identify and accurately readout the numerical values of an individual point without having to position the mouse exactly over it. When displaying more than one layer you must select the layer which is to be used for displaying the "hopping" point cursor. This layer is known as the Working Layer. The numerical values of the point cursor are displayed in the "Point" text box, while the normal mouse cursor position is displayed in the "Cursor" text box. Values are shown in date-time and meters (or meters per second in the case of tidal streams).

Deleting a Single Point with the Keyboard

To delete an individual point, simply move the cursor left or right until the point cursor hops to the point you want to delete. Press the delete key on the keyboard, and you will be prompted to confirm that you want to delete this point.

Deleting One or More Points with the Mouse

To delete one or more points at once, drag the mouse across the points which you want to delete whilst holding down the left mouse key. As you drag the mouse a rectangle is drawn, and the points within this rectangle are the points you are selecting for deletion. When you release the mouse button you will be prompted for confirmation that you want to delete these selected points.

When you delete points from the Working Layer you can still see the points you have deleted by looking at the Original Layer provided it is checked in the Plot Controller window.

Points can be manually edited at any time therefore 'manual' is not an Edit menu item. See Graphic Operation for other details

4.5 Undo

Click the main menu item **Edit>Undo** to carry out this operation.

On most operations **Undo** restores the tidal record as it was immediately prior to the operation being carried out. For example if filtering, sampling or averaging has been carried out and **OK** was clicked on the respective window, the original record can be restored by clicking **Undo**. The original and working log are always modified accordingly.

4.6 Revert

Click the main menu item **Edit>Revert to Original** to carry out this operation.

Revert to Original reloads the last tidal record which was loaded. The original and working log are modified accordingly and all edit operations which have been carried since the tidal record file was loaded - will be lost.

Part

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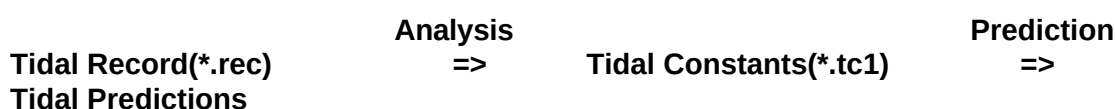
Harmonic Analysis

5 Harmonic Analysis

Harmonic Analysis is the process of converting the tidal data into harmonic constants.

Before carrying out a tidal harmonic analysis you should ensure that the tidal record is of sufficient quality, i.e. all erroneous (rogue) data points have been removed and that it is of sufficient duration. The number of harmonic constants to be found is determined by the tidal scheme. A more complex scheme will require a longer data duration, while a simple scheme will operate more reliably on data of a shorter duration. Ideally tidal records should contain between 1000 and 1 million data points, covering anything from 14 days to 18 years. The points do not have to be a regular continuous record and gaps within the record are quite acceptable.

The general process is

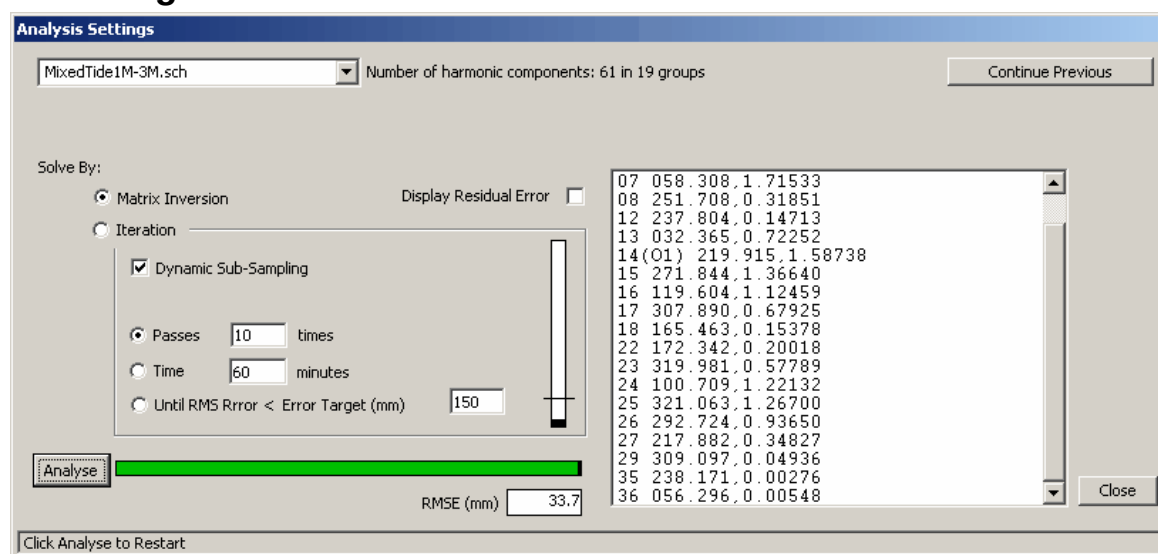


After loading a tidal record which of sufficient quality and duration, Tidal Harmonic Analysis is carried out to obtain the Tidal Constants File. This can then be used either within GeoTide Analyzer or within GeoTide Predictor to make high accuracy tidal predictions.

In **GeoTide Analyzer**, the tidal analysis is always carried out on the **working layer** with its results appearing on the **Analysis layer**.

The tidal harmonic analysis can be carried out in two ways, by Matrix Inversion or by Iteration.

5.1 Selecting a tidal scheme



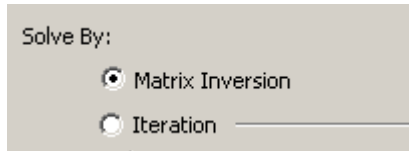
Click the **Analysis** menu on the main screen to display the **Analysis** window, a portion of which is shown above.

To begin tidal analysis, the user must first select a tidal scheme from the pull down text-

box shown above.

A number of Analysis Schemes are included with the GeoTide Analyzer. They are listed in the readme.txt file which is installed with the program.

5.2 Solve By



Solve By: Matrix Inversion or Iteration

These button options enable you to select the analysis method. These are:-

Matrix Inversion

Fast and accurate using the exact mathematical inverse of the prediction process. Cannot handle the UKHO Simplified method with Shallow Water Corrections.

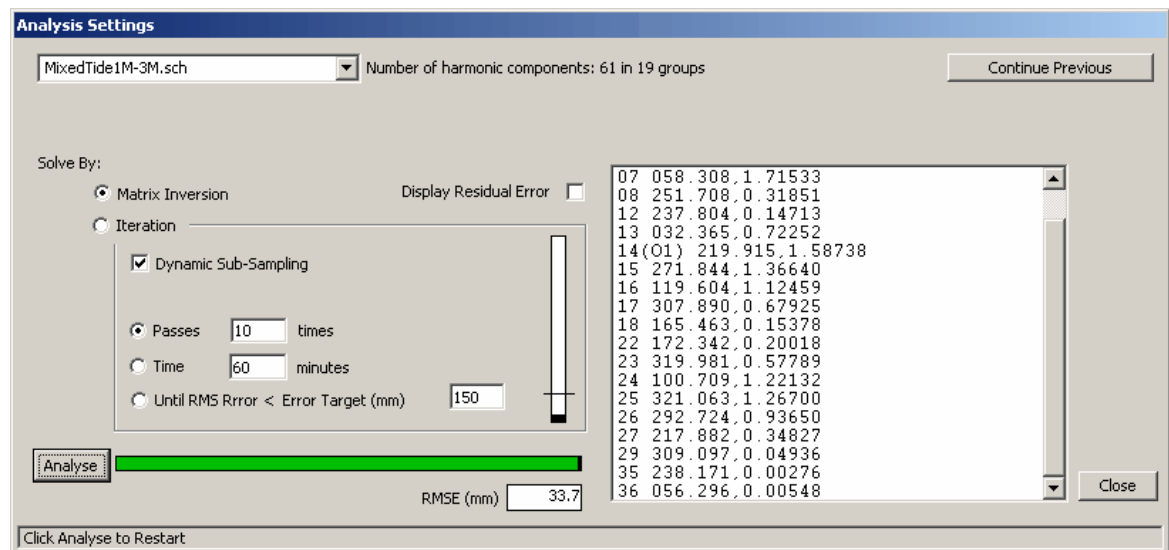
Iteration

Slower than Matrix Inversion.

Uses the identical forward mathematics as in the prediction algorithm.

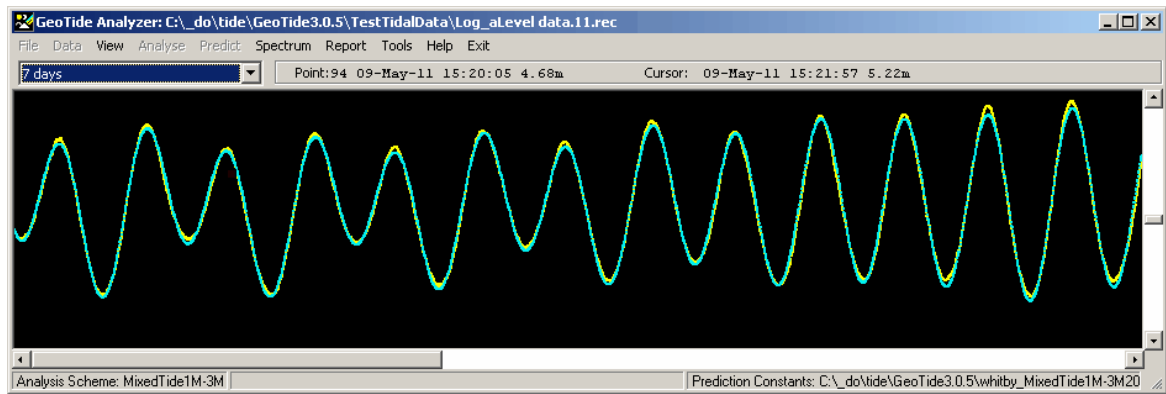
Can handle all type of analysis including UKHO Simplified method with Shallow Water Corrections.

5.2.1 Matrix Inversion



When the Matrix Inversion option is selected there are no further choices to be made. Simply click the Analyse button to carry out the analysis..

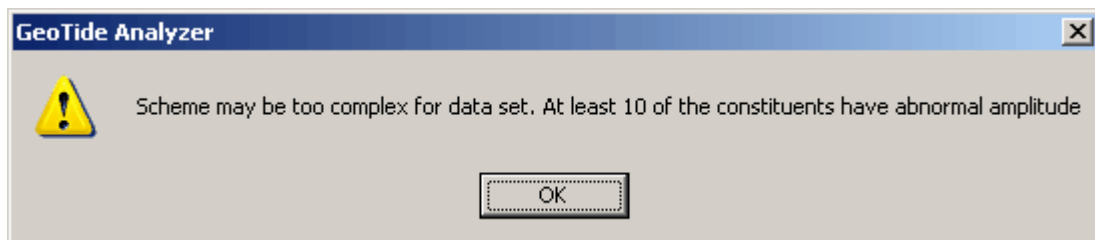
At the completion of the analysis by matrix inversion, a graph is displayed in the **analysis layer**, shown in blue, while the original data is shown in yellow.



In the above example there is good agreement between the two.

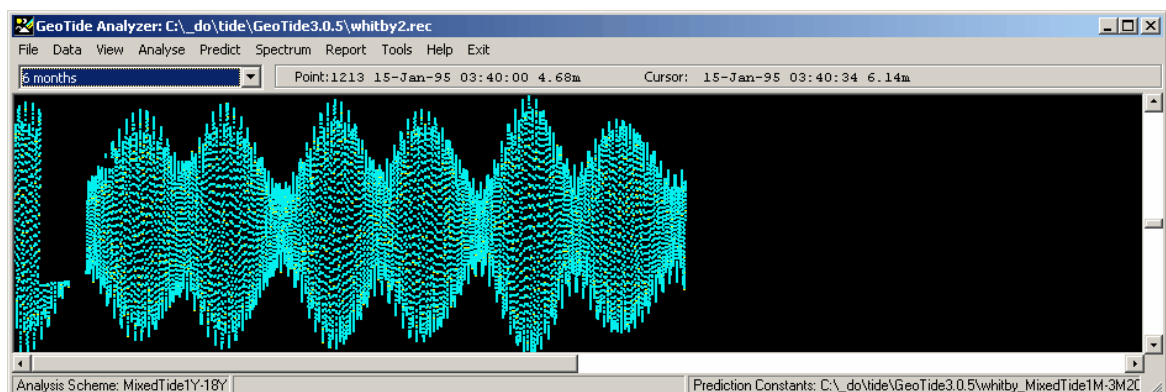
Our matrix inversion algorithm is blisteringly fast and normally provides no problems.

However when a scheme has been chosen which is too complex for the duration of the data the following warning or similar is displayed.



For example in the above case when selecting a mixed tide of between 1 year and 18 years analysis the error message is displayed.

The data duration can be readily determined by observing the messages for that layer in the Plot Controller or by using the pull down menu above the graph on the main window at the top left. This is shown below and is around 4 months duration.



In this case it is better to choose a tidal scheme which is designed for a shorter tidal duration.

5.2.2 Iteration

Click the **Analysis** menu on the main screen to display this window whose functions are reviewed here.

Select Tidal Analysis Scheme

A list of tidal schemes from which the user should select the scheme they want to use.

Load Previous

You can optionally click this button to load a previously save harmonic constants file in which case the process starts from these saved values and not from zero.

Analyse

Click to commence the analysis process. Once running its label changes to Stop so that you can halt the process.

Cancel

Click to cancel the analysis process.

OK

Click to close the analysis process.

Iteration Options

- **Until RMS Error is less than the Error Target**
Halts the process when the error target is reached.
- **Iterate for n passes**
Halts the process after n times around.
- **Iterate for n minutes**
Halts the process whenafter n minutes.

Error Target

Sets the value for the error target and changes the scale of the error and progress thermometers.

Dynamic Sub Sampling

Checking this box increases the speed at which the program finds the harmonic constants.

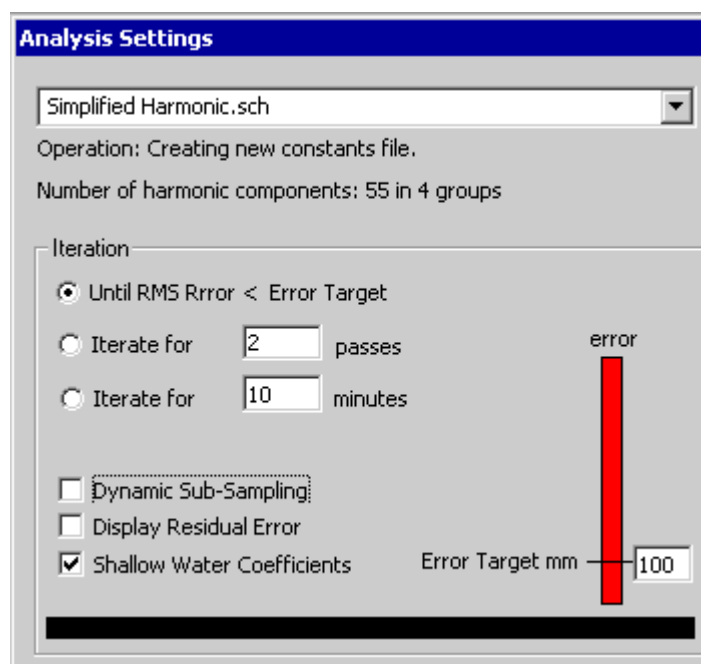
Display Residual Error

Checking this box causes the residual error (i.e. the difference between the observed and predicted) to be displayed rather than the predicted curve.

Shallow Water Coefficients

This check box enables an algebraic correction for non-linear tidal effects resulting in the calculation of Shallow Water Coefficients. Only the UKHO Simplified Scheme currently supports this method.

5.2.2.1 Iteration Options



The iteration options are:

Until RMS Error is less than the Error target

Use this option to stop the iteration when the error target has been attained. During iteration the progress bar will display proportionately to the error attained. You can change the required error target as described below..

Iterate for n passes

Select this option to Iterate for a given number of passes. You should enter the number of passes required in the text-box provided. During iteration the progress bar will display proportionately to the number of passes being carried out.

Iterate for n minutes

Use this option to iterate for a given length of time. You should enter the time in minutes in the text box provided. the progress bar During iteration the progress bar will display proportionately to the elapsed time.

Error Target

You can change the error target by changing this number on the Analysis Screen. Notice that changing the value of the error target will automatically scale the error bar thermometer which is displayed.

Residual Error

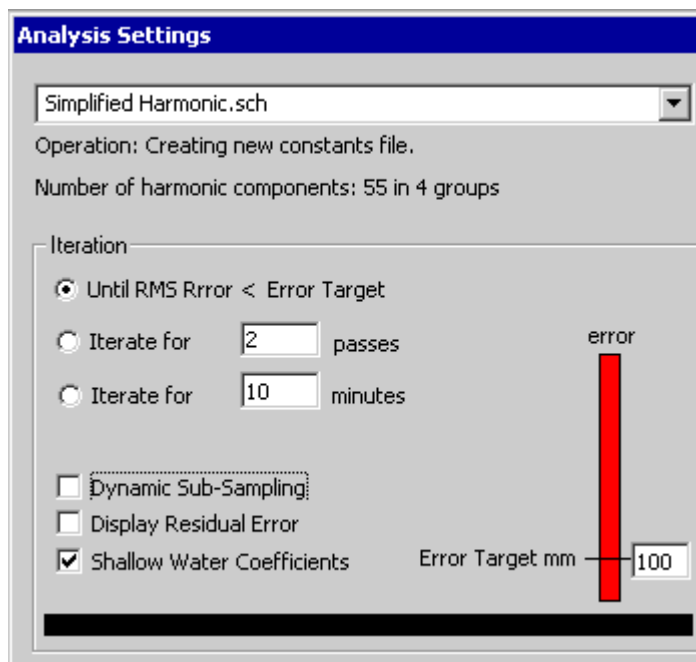
This checkbox displays the residual error, which is the difference between the above graphs rather than the predicted graph itself. Using this option together with the Spectrum Analyser enables you to search for missing components more easily.

Dynamic Sub Sampling

The checkbox increases the speed at which the program determines the harmonic constants. It does this by sub-sampling the loaded tidal record. The sampling interval dynamically varies, so that as the error target is reached more and more points are used from within the record. It can be clicked while the iteration is in progress.

Shallow Water Corrections are described in the following section.

5.2.2.2 Shallow Water Coefficients



Shallow Water effects can cause the tide to be non-sinusoidal, in extreme cases resulting in standing tides or extra tides. These are handled in GeoTide Analyzer in two ways, via harmonic overtones (included in the tidal scheme file) or by an algebraic correction called the Shallow Water Correction.

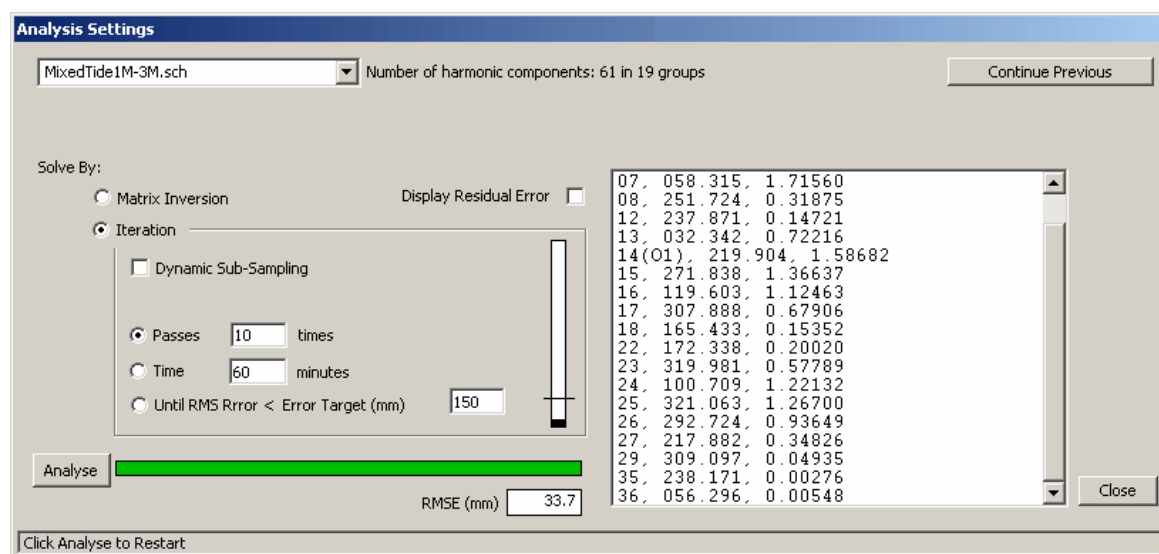
Shallow Water Corrections

This check box is displayed on the Harmonic Analysis window (shown above) only for those tidal schemes which are appropriate, currently the UKHO Simplified Scheme. Selecting the Simplified Scheme (which uses this method) displays the checkbox. When checked, Shallow Water Corrections are algebraically generated for the group within the scheme.

Shallow Water Corrections allow for non-linearity within the ocean in terms of its response to the tidal gravitational potential. As such they allow for the amplitude and phase of the overtones of the major harmonic components of the tide raising potential. In the UKHO Simplified Scheme they are algebraically calculated for the overtones of only the semi-diurnal components, corresponding to the 4 times per day and six times per day components. They are accordingly labelled f4,F4 ,f6,F6, in the location harmonic constants log - where the lower case indicates the amplitudes and the upper case indicates the phase in degrees.

Shallow Water effects are described more fully in the Shallow Water Coefficients theory section.

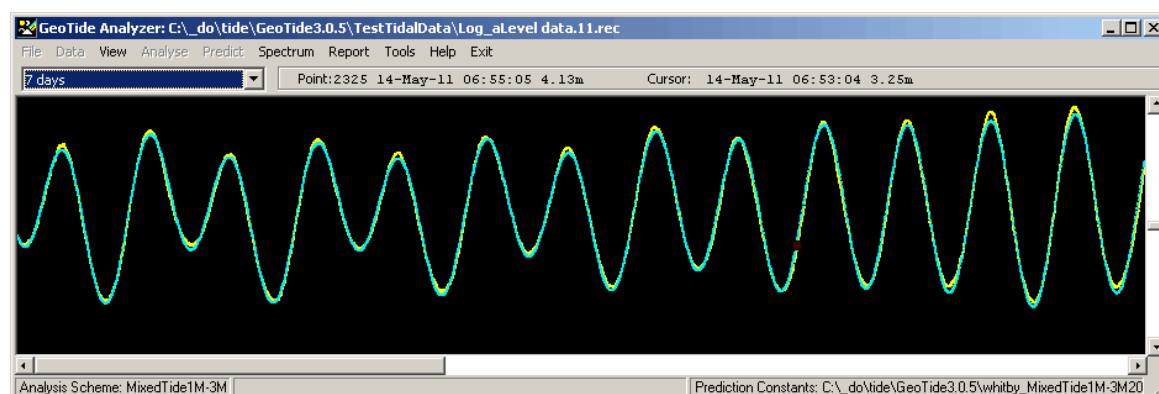
5.2.2.3 Analyzing



Click **Analyse** to initiate the iteration process.

Once clicked, the system continuously displays the progress of the tidal analysis, both as a thermometer on this screen and by displaying an extra graph in the main screen in the Analysis Layer - see below. The window contains a vertical thermometer which displays the RMS Error and the horizontal black bar which displays the progress of the iteration. The information box in the lower window area gives you the error which has been attained.

During analysis, a trial graph is continuously written to the **analysis layer**, and as time progresses the graph which emerges becomes increasingly similar to the **working layer**. The analysis graph below is shown in blue, while the original data is shown in yellow. When the iteration condition has been attained the iterative process stops. Alternatively you can click the Analyse button (now labelled Stop) to halt the process.



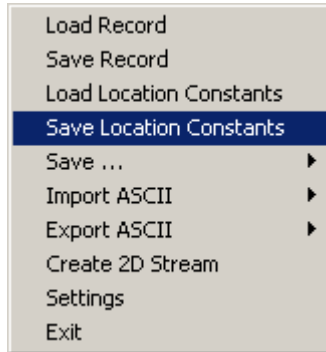
The information box, at the lower centre of the tidal analysis window, shows the R.M.S. error as 33.7mm. This is calculated for all of the points in the Working Layer. You can also view the harmonic constants produced by accessing the menu option View>Analysis Constants.

To conclude the Analysis session, leaving the harmonic constants in memory, you should click the **OK** button. Click **Cancel** to exit the session without leaving the harmonic

constants in memory.

The next section describes how to save the harmonic constants you have created.

5.3 Saving Harmonic Constants



After completing an analysis you should always save the harmonic constants by clicking **File | Save Location Constants** and entering the filename. You can save the location constants file anywhere on your computer system, it does not have to be saved in the same folder as the tidal record from which it was derived. However, we strongly recommend that you adopt a standard folder structure for your work. If you have many tidal locations you may want to create a folder for each location, each containing the appropriate tidal record and harmonic constants files. Or you may decide to have a folder for the data and a folder for the constants.

You can also export the harmonic constants file by clicking **Export | Analysis Constants**.

You can view the constants in the window on the Analysis page.

Finally you can place the constants in a report by using the **Report** facility.

Part



VI

Predicting

6 Predicting

Clicking the **Prediction** menu on the main screen displays the Graph Prediction window.

The screenshot shows the 'Graph Prediction' dialog box. It includes the following elements:

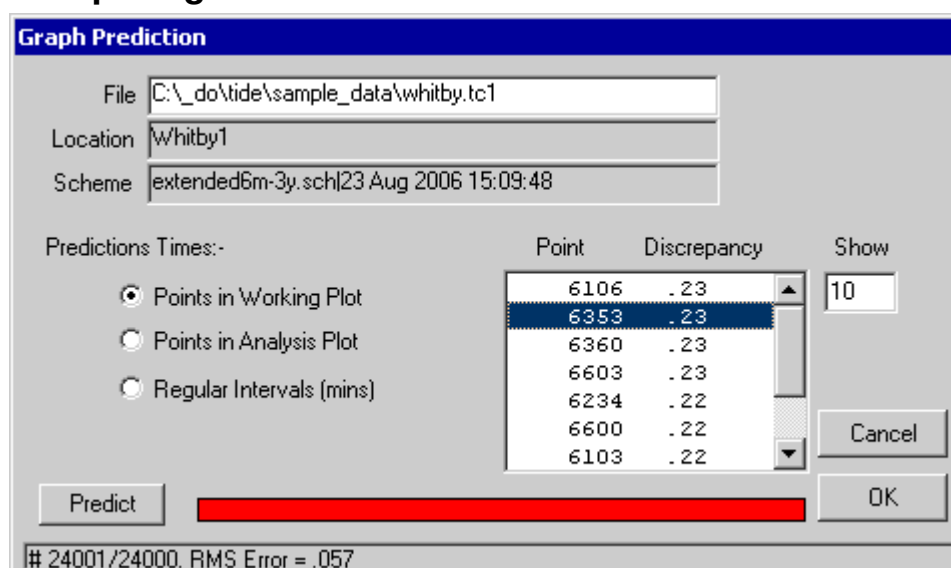
- Tidal Constants:** A text box containing the file path `C:\_do\tide\GeoTide3.0.5\whitby_MixedTide1M-3M20140625152522.tc1`.
- Location:** A text box containing 'Whitby Harbour'.
- Scheme:** A text box containing 'MixedTide1M-3M.sch|06 Dec 2011 11:32:33'.
- Predictions Times:-** Three radio button options:
 - ☒ Points in Working Plot
 - ☐ Points in Analysis Plot
 - ☐ Regular Intervals (mins)
- Plot Area:** A large empty rectangular box for the graph.
- Labels:** Above the plot area are the labels 'Point', 'Discrepancy', and 'Show'.
- Show Button:** A button to the right of the plot area with the text '10'.
- Buttons:** At the bottom are 'Predict', 'Cancel', and 'OK' buttons.

This facility creates tidal predictions from harmonic location constants which you have previously saved.

It can be used to compare predicted values with observed values, and to predict and plot a tidal curve for comparison with an observed plot. In either case, you must first select the desired location constants by clicking the text-box labelled File. Then select the type of prediction times to be used. The options are to :-

- use times from points in the working layer
- use times from points in the analysis layer
- predict at regular intervals

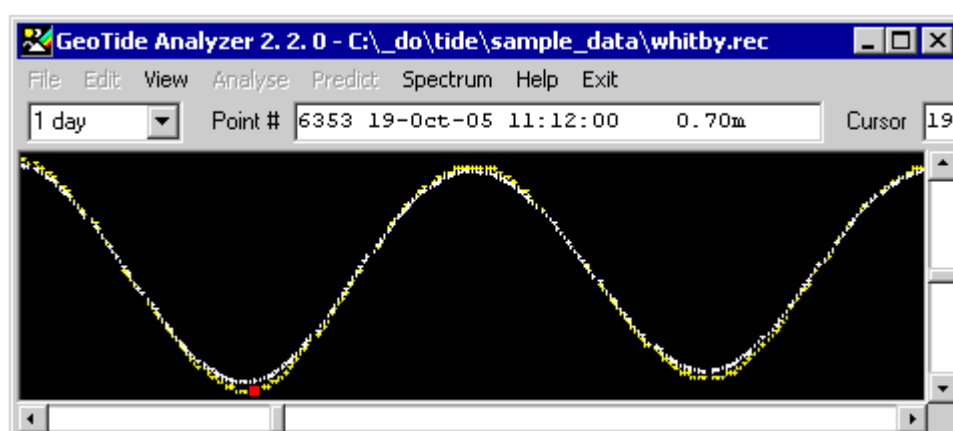
6.1 Comparing Predicted & Observed



Click either Points in **Working Plot** or **Points in Analysis Plot** to use the times of the points in the respective layers as the prediction times. When using either of these two options, the predicted points will naturally line up with the source points. This means that the system can calculate and show the height discrepancy between the predicted and observed or analysed graphs. The points with the greatest height discrepancy are listed in the text-box labelled Point Discrepancy. They points are shown in reverse order of size of discrepancy. The error shown is the RMS error in meters. You can change the number of such discrepant points displayed by entering the number in the text-box labelled Show.

This facility can also be used to locate and eliminate erroneous data points such as may be caused by typographic errors, tide gauge problems or unusual meteorological effects such as storm surges. To do this arrange that the main graph window and prediction window are both visible.

To identify a point listed in the Point Discrepancy List click the point in the list as shown in the above screenshot.

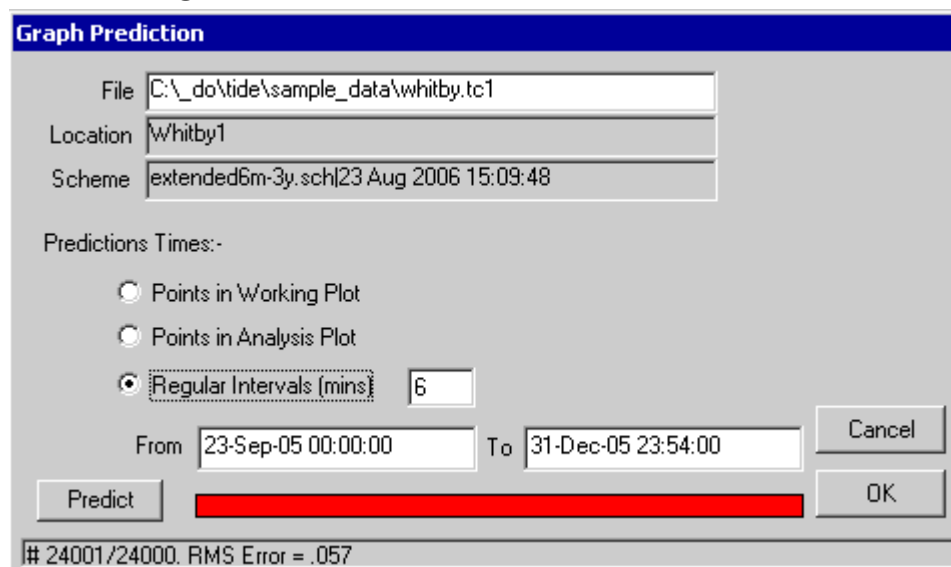


The main graph window will simultaneously show this point as the active point by moving the red square point cursor to that point. It will also scroll as necessary, so that the point can be seen on the display. Its value and height can be read from the Point # cursor readout. This facility can be used at any graph scale setting. You can delete this point if

required by simply pressing the delete key. Or you can delete any number of points by using the mouse drag facility.

After deleting the point(s) the system will automatically update the discrepancy list.

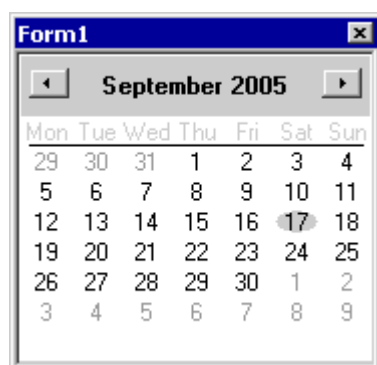
6.2 Tide at regular intervals



The **Graph Prediction** dialog box contains the following fields and controls:

- File:** C:_do\tide\sample_data\whitby.tc1
- Location:** Whitby1
- Scheme:** extended6m-3y.schl23 Aug 2006 15:09:48
- Predictions Times:-**
 - ☐ Points in Working Plot
 - ☐ Points in Analysis Plot
 - ☒ Regular Intervals (mins)
- From:** 23-Sep-05 00:00:00
- To:** 31-Dec-05 23:54:00
- Buttons:** Predict, Cancel, OK
- Status Bar:** # 24001/24000. RMS Error = .057

The option to predict at Regular Intervals predicts the tide at regular intervals times between a given start date and end date. By default the start and end dates are derived from the start and end dates of the record in the working layer. However the start and end date can be entered into the text-boxes provided, or if you double click the date box you can select the dates from a calendar (shown below). The time interval for predictions can be set in the text box provided.



Form1 displays a calendar for **September 2005**. The calendar grid shows days of the week (Mon to Sun) and dates. The date **17** is highlighted.

Mon	Tue	Wed	Thu	Fri	Sat	Sun
29	30	31	1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	1	2
3	4	5	6	7	8	9

Click the **Predict** button to create the predicted curve.

Note that with this option the discrepancy figures cannot be calculated, since there is no correspondence in time between the points with the graphs.

Part



VII

Reporting

7 Reporting

A versatile report generator is included within **GeoTide Analyzer** which enables you to produce a fully formatted report.

This report contains:-

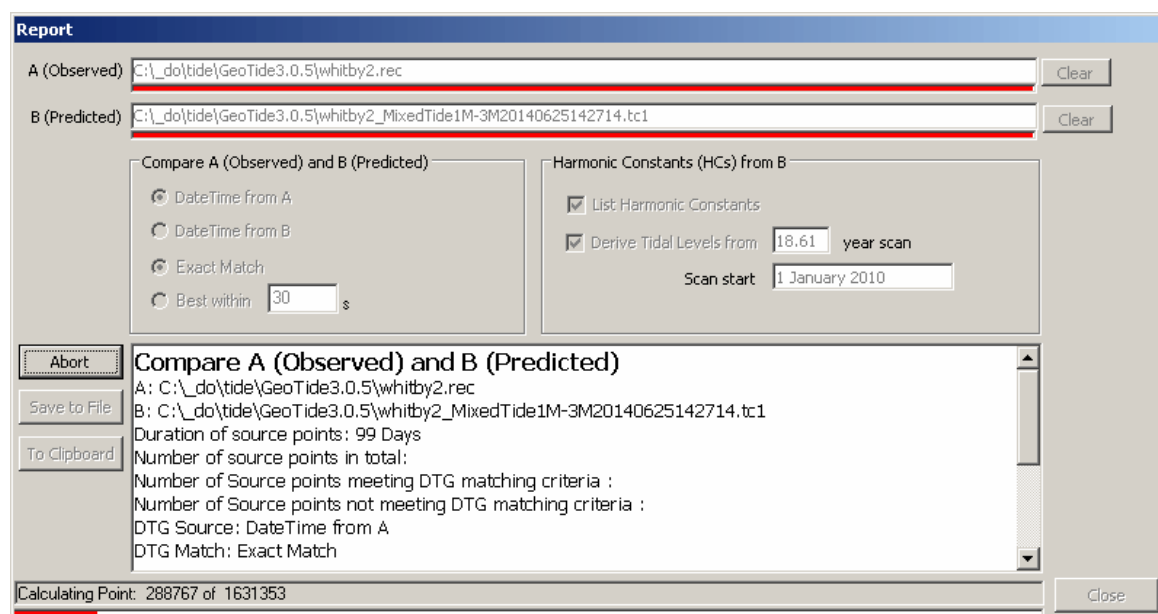
- The results of a statistical analysis of the comparison of observed and predicted data
- The tidal levels: HAT, MHWS, MHHW, MHW, MHWN, ML, MLWN, MLW, MLLW, MLWS, LAT
- A listing of the harmonic constants for that location.

The report is generated in Rich Text Format (.rtf) which is compatible with most word processors including Microsoft Word.

The predicted data is normally generated by comparing predictions derived from a GeoTide harmonic constants (.tc1) file with data in an observed (.rec) data file.

You can also compare two tidal record files - enabling you to generate a report on the level of agreement with externally generated data.

7.1 Functional Overview



Clicking the **Report** menu on the main screen displays this window. It comprises:

Facilities for

- Loading Observed data
- Loading Predicted data

Options for Comparing Observed and Predicted Data

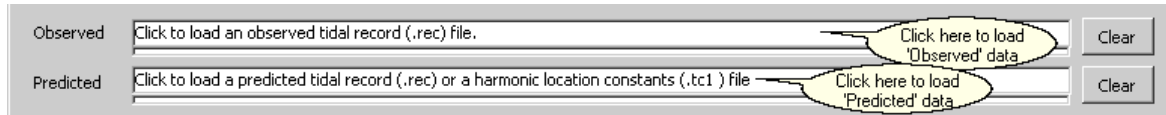
Options for Setting Parameters to be derived from Harmonic Constants (HCs) if loaded.

A **Create Report** button and report display.

Facilities for saving, printing and copying the report.

A **Close** command button for closing the window.

7.2 Loading Data



Clicking the labels loads the files as indicated. Beneath each label is a thermometer style progress bar showing the loading progress. During loading, the label of these buttons changes from **Clear** to **Abort** - thereby providing the user with the opportunity to halt the load operation. The user can also unload a loaded file by using this button.

Observed Data

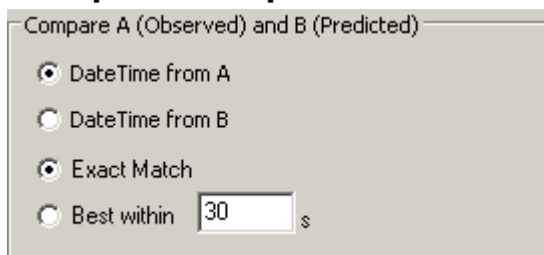
The observed data must be loaded from a tidal record (.rec) file. This box is synonymous with the **File>Load** option on the main menu.

Predicted Data

Normally the predicted data is derived from a harmonic constants (tc1) file. Therefore a user should click and load the relevant harmonic constants (.tc1) file for the location. When loading such a file, the tide is calculated at each of the points within the "observed" file (if loaded). Therefore the time taken to load increases considerably. This is indicated in the progress bar. Also the progress is indicated numerically in the lower information bar (not shown above) in terms of number of records calculated.

Exceptionally it may be required to compare two tidal record files, for example when one has been generated externally. Such an external prediction file should first be imported and saved in the usual manner. Then it should be loaded as Predicted data by clicking the appropriate (.rec) file. In this circumstance the comparison options are enabled but the harmonic options are not.

7.3 Comparison Options



The above comparison options are enabled when both Predicted and Observed data are loaded.

Date Time From Observed / Date Time From Predicted

Determines the source of the Date Time (DTG) to be used for comparison. If 'Date Time From Observed' is chosen the system attempts a comparison at each DTG in the Observed record. Similarly if 'Date Time From Predicted' has been selected the system attempts a comparison at each DTG in the Predicted record. Normally, the Predicted record will have been created from a loaded harmonic constant file at the times in the Observed record, and so the two sets of data will have identical DateTimes. However in cases where the Predicted file has been loaded as a tidal record file this setting becomes

important.

Exact Match / Best Within

Determines the degree of difference which is tolerated between the DateTimes in the Predicted and Observed records. Normally, the Predicted record will have been created from a loaded harmonic constant file at the times in the Observed record, and so the two sets of data will have identical DateTimes. However in cases where the Predicted file has been loaded as a tidal record file this setting, and its corresponding time value becomes very important.

Other

In addition the software automatically provides the following outputs in the report.

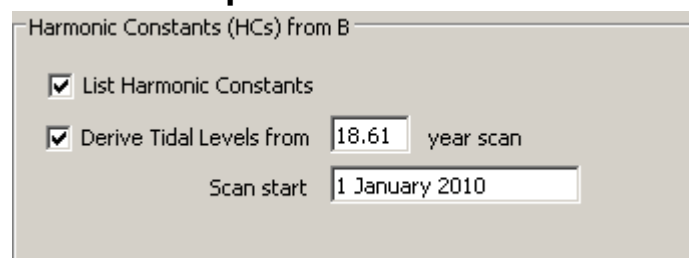
RMS Error (Quadratic Mean). This is the RMS Error figure between the two data sets.

Mean Absolute Error. This is the average of the absolute value of the error figures i.e. without regard to its sign.

Maximum Positive Error. The largest positive value of difference between observed and predicted.

Maximum Negative Error. The largest negative value of difference between observed and predicted.

7.4 Harmonic Options



The above Harmonic Constant options are enabled when a valid harmonic constants file has been loaded as a Predicted record. The checkbox options are

List Harmonic Constants

Check this box to output the list of harmonic constants within the report.

Derive MHWS MHWN MLWS MLWN HAT LAT ML

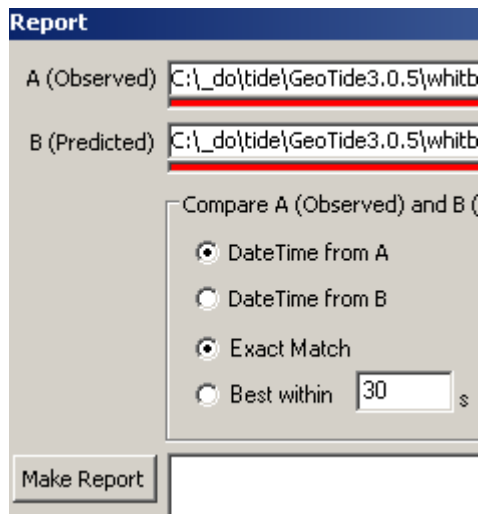
This causes a scan to be carried out of specified duration starting on the specified date. The computer uses a brute force method to calculate the tidal parameters shown. The default duration is 18.61 years after which the tides approximately repeat. When checked, the figures are automatically included in the report. Note that checking this option considerably slows production of the report, which may take many minutes to produce. The date formats should be entered as shown.

Other

In addition the software always reports the High water Lunitidal Interval as derived from the phase of M2

7.5 Generating

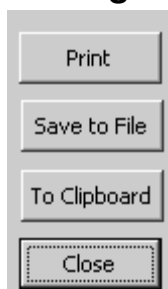
To generate a report click **Generate Report** button.



Depending on the options chosen it may take a considerable time to produce the entire report, perhaps many tens of minutes.

The progress is indicated in the information text box at the lower edge of the window.

7.6 Saving



The above buttons are used to output the report. In each case its output is in Rich Text Format (RTF) which is compatible with most word processors including Microsoft Word.

Print

Causes the document use the loaded printer driver to print out to user specifiable printer with the usual options.

Save to File

Causes the document to be save d in a use specifiable location.

To Clipboard

Saves the file as an RTF document in the Windows Clipboard

Close

Closes the window and return to the main screen.

Part

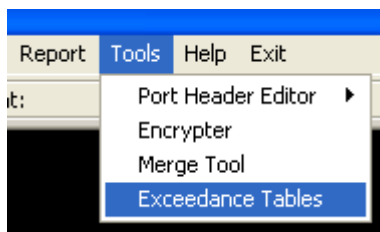


Tools

8 Tools



The Tools Menu provides additional facilities which are added to GeoTide.



Port Editor

The Port Editor enables you to change the port details which are held within the tidal record file (.rec) or tidal constants file(.tc1). You may want to change these detail because they may have been entered incorrectly when you originally imported the data or they may have changed for other reasons. For example you can enter an additional name in a local script e.g. Arabic or Chinese, or you can change the default time-zone here. These details which can be changed are currently:-

- Port Name
- Gauge ID
- Time Zone
- Position - Latitude and Longitude.

These same details appear verbatim upon the tide tables and graphs produced by GeoTide Predictor.

Encrypter

Using the Encrypter utility you can encrypt the harmonic constants which are distributed to an end user, thereby preventing them from hacking the distribution code and recovering the constants.

Merge Tool

The optional Merge Tool enables you to combine GeoTide Record files. This may be a requirement, for example, as more tidal data becomes available from a tidal monitor.

Exceedance Tables

Generates Tidal Exceedance Tables of 3 different types: High Tide, Maximum Daily, and All Points.

8.1 Port Editor

The Port Editor enables you to change the port details within the record file or tidal constants file.



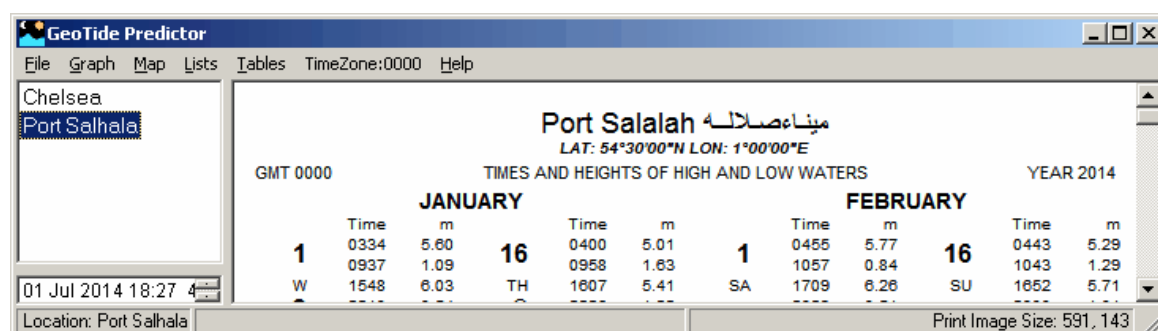
These details which can be changed are currently:-

- Port Name
- Gauge ID

- Time Zone
- Position - Latitude and Longitude.

These details appear verbatim upon the tide tables and graphs produced by GeoTide Predictor.

You may want to change these details because they may have been entered incorrectly when you originally imported the data or they may have changed for some other reasons. For example, a location may have been renamed, its time-zone may have changed, or you may require to enter an additional name in a local script e.g. Arabic or Chinese. The tables in GeoTide Predictor can then contain the local script within the displayed title and can display the updated information.



The difference between the two options is now described.

Record File

Making changes to the data in the Records File (i.e. the file with file extension .rec) means that all subsequent analysis using that record file will incorporate the changes you are making. As well as filtering down into the tidal constants file the changes will also subsequently appear into all tide tables, tide listing and prediction graphs made using this constants file within GeoTide Predictor.

Constants File

Making changes to the data in the Constants File (i.e. the file with file extension .tc1) means that the changes will filter down subsequently into all tide tables, tide listing and prediction graphs made using this constants file within GeoTide Predictor. However, if you carry out a new tidal analysis using the original record file the changes entered will be overwritten with those in the record file and will **not** incorporate the changes that you are make.

8.1.1 Record File

Clicking the option Record File displays the Record File Editor.

The screenshot shows the "Record File" dialog box. It has a title bar "Record File". Inside, there are five input fields: "Location Name" with the value "Whitby Harbour", "Gauge ID" with the value "Whitby Harbour", "TimeZone" with the value "0", "Latitude" with the value "54°12'N", and "Longitude" with the value "0°1'E". At the bottom right, there are two buttons: "Cancel" and "OK".

Here you can change following data.

Port Name

This name will appear on all tables derived from this tidal constants.

Note that you can enter here optional non western characters using their html equivalents.

If the western (ASCII) characters are to appear first they must be separated from the non-Western characters by for example as:

Port Salalah مينـاءصـلالــه

Or if the Arabic is required first:

مينـاءصـلالــ&#1607 Port Salalah

Gauge ID

Enter as an ASCII string.

Time Zone

Enter here four digits representing hhmm with an optional + or - prefix.

Note the prefix is + for West and - for East. This is the UKHO standard for time zones and is the opposite way round from many modern documents e.g. telephone directories etc.

Position

Latitude - entered as dd°mm.mm' followed by N or S

Longitude - entered as ddd°mm.mm' followed by E or W.

8.1.2 Constants File

Clicking the option Constants File displays the Constants File Editor.

Here you can change following data.

Port Name

This name will appear on all tables derived from this tidal constants.

Note that you can enter here optional non western characters using their html equivalents.

If the western (ASCII) characters are to appear first they must be separated from the non-western characters by for example as:

Port Salalah مينـاءص
ـلالــه

Or if the Arabic is required first:

مينـاءصـل
الــ&#1607 ـPort Salalah

Gauge ID

Enter as an ASCII string.

Time Zone

Enter here four digits representing hhmm with an optional + or - prefix.

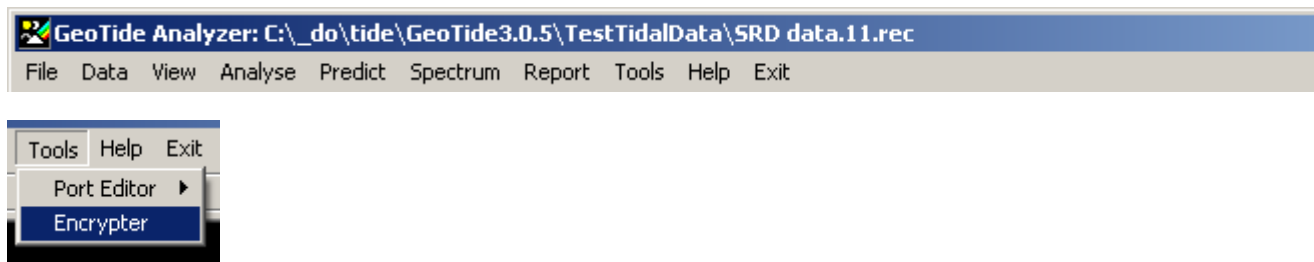
Note the prefix is + for West and - for East. This is the UKHO standard for time zones and is the opposite way round from many modern documents e.g. telephone directories etc.

Position

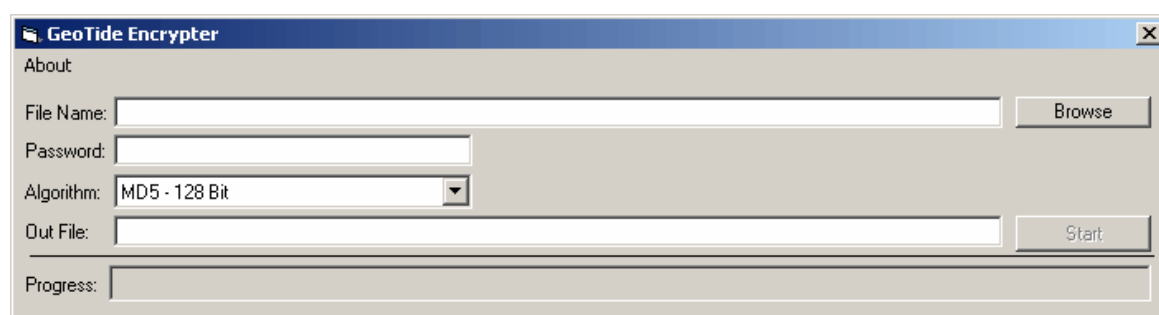
Latitude - entered as dd°mm.mm' followed by N or S

Longitude - entered as ddd°mm.mm' followed by E or W.

8.2 Encrypter



Select the Encrypter option to display the Encryption Tool shown below.



This is used as the final step before distributing tidal constants.

Encrypting the information using a password means that users of the GeoTide Predictor program will not be able to hack the harmonic constants.

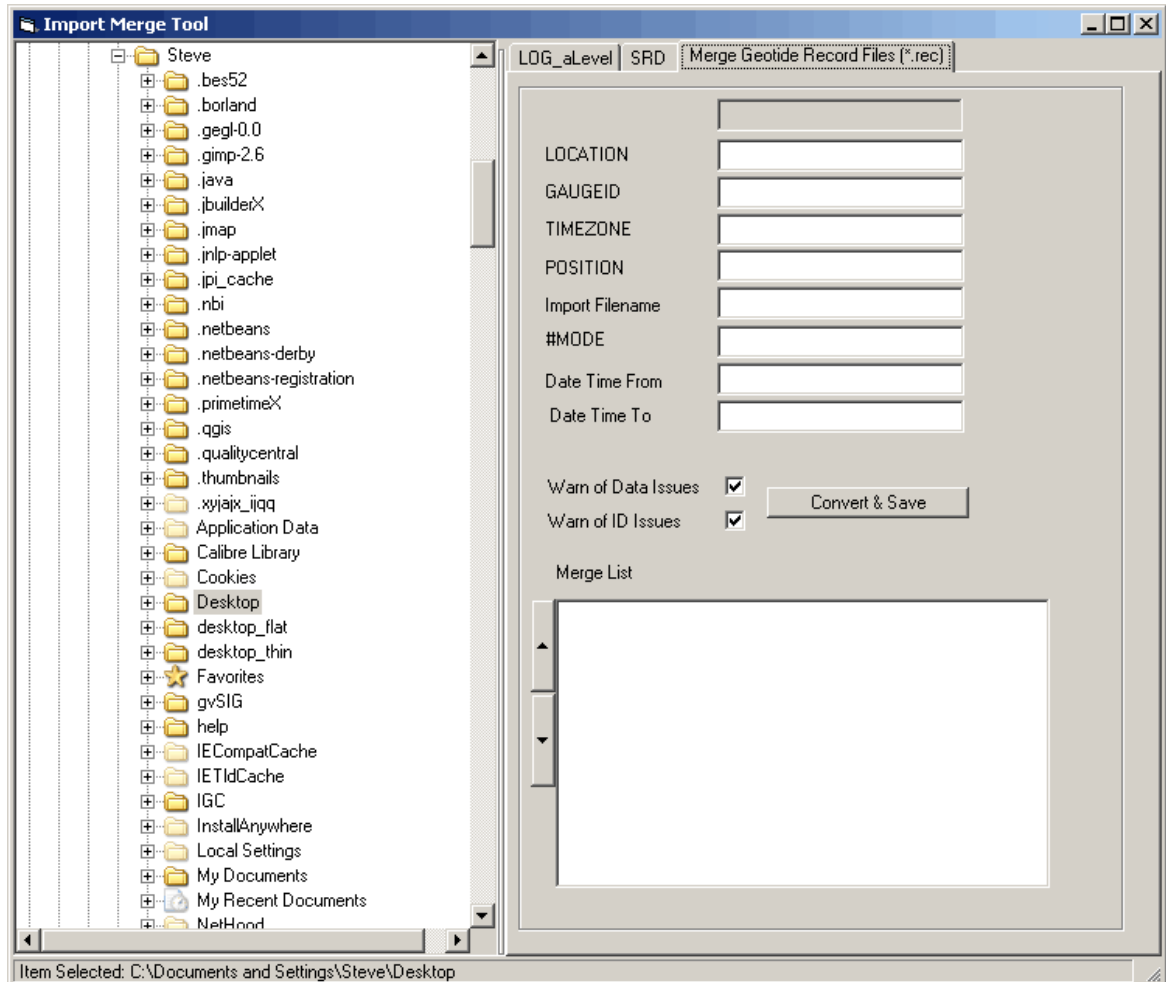
The same password as is used here, must be entered into the GeoTide Predictor Settings Panel, and once entered it is stored within the GeoTide Predictor user configuration.

If a number of tidal constants files are to be distributed for use in the GeoTide Predictor, the same password must be used for each tidal constants file distributed.

Please contact us for details.

8.3 Merge Tool

Clicking Tools | Merge Tool runs the ImportMerge Tool facility shown below.



This includes facilities for importing from Tide gauges manufactured by Log_aLevel and Sonar Research and Development (SRD) and also for merging GeoTide .rec Files.

1. Simply select the tab for whether you want to use Log_aLevel, or SRD or whether you wish to merge Record files.
2. Select the files you wish to convert or merge. When merging you can select the order of the merge by selecting the file in the MergeList window and using the up and down arrows.

Click Convert and Save or Merge. You will be prompted for a filename.

8.4 Exceedance Tables

Create Tidal Exceedance Table

Source Layer: Original

☒ High Water

Search Width (hrs): 1

Minimum Number of Points: 5

Height Threshold (m): 3

Reject Multi-Tides (hrs): 5

☐ Daily Maxima

☐ All Tide Data Points

Table Interval (m): 0.1

Ht format (m): 0.000

Percent format (%): 0.0

Go

High Tides: Exceedance Table

Y(m)	N(i)	N>Y	%>Y
6.600	0	0	0.0
6.500	1	1	0.4
6.400	0	1	0.4
6.300	6	7	3.1
6.200	2	9	4.0
6.100	3	12	5.3
6.000	13	25	11.1
5.900	10	35	15.5
5.800	6	41	18.1
5.700	6	47	20.8
5.600	8	55	24.3
5.500	10	65	28.8
5.400	12	77	34.1
5.300	20	97	42.9
5.200	24	121	53.5
5.100	15	136	60.2
5.000	14	150	66.4
4.900	21	171	75.7
4.800	13	184	81.4
4.700	15	199	88.1
4.600	13	212	93.8
4.500	6	218	96.5
4.400	4	222	98.2
4.300	2	224	99.1
4.200	2	226	100.0

High Tides: List

01/01/2015 11:48:32	5.409
02/01/2015 00:14:44	5.111
02/01/2015 12:45:01	5.391
03/01/2015 00:43:20	5.385
03/01/2015 13:17:01	5.406
04/01/2015 02:04:44	5.395
04/01/2015 14:27:06	5.349
05/01/2015 02:58:16	5.579

Completed.

This facility generates tidal exceedance tables of three types, High Water, Daily Maxima and All Points. Exceedance tables are useful for assessing the deepest draft of vessel which may regularly access a harbour and also for estimating overtopping and flood risk.

The source data for the table can be derived from one of the 4 graphical layers using the listbox at the upper left. The table is displayed in the text area on the form. In the cases of High Water and Daily Maxima tables the text area also lists, below the table itself, the maxima which have been used to create the table.

Note:

1. The contents of the text window can be selected and copied to other software e.g. Microsoft Excel using the right mouse button and highlighting or select all.
2. The window can be maximised or resized.

ListBox

Selects which graph layer to be used as data source: Original, Working, Analysis, Predicted.

High Water

Selects the type of table.

Search Width

Only applies to High Water Exceedance Tables. Sets the search window width in hours. This width is used for determining a turning point.

Minimum Number of Points

Only applies to High Water Exceedance Tables. Sets a minimum in hours. This width is used for determining a turning point.

Height Threshold

Only applies to High Water Exceedance Tables. Rejects all turning points with a value below this figure.

Reject Multi-Tides

Only applies to High Water Exceedance Tables. Rejects Standing / Extra / Multi-Tides occurring within this time (in hours). The highest turning point within the time window is chosen for the exceedance table.

Daily Maxima

Selects the type of table.

All Tide Data Points

Selects the type of table.

Table Interval

Applies to all types of table. Sets the value of the row interval in the table.

HT Format

Applies to all types of table. Provides the format string for the listing of height in column 1 of the table.*

Percent Format (%)

Applies to all types of table. Provides the format string for the listing of percent in column 4 of the table.*

*Uses standard Microsoft / VBA / Excel format strings such as "#0.00".

Go

Click this command button causes the table to be calculated and displayed

Part



IX

Spectrum Analyser

9 Spectrum Analyser

GeoTide contains a fully featured tidal spectral analyser accessible from the Spectrum top-menu.

Spectral analysis converts a time series into a spectrum, showing the power of each frequency plotted on a graph with power on the vertical axis and frequency horizontally. Acting in a manner analogous to a glass prism which splits light into its component colours, spectral analysis in tidal work can reveal the presence of missing or unexpected harmonic components.

Unlike tidal harmonic analysis which searches for and fits the amplitude and phase of **only known tidal constituents**, spectral analysis can reveal the power of **any frequency** present, even those not predicted by linear tidal theory.

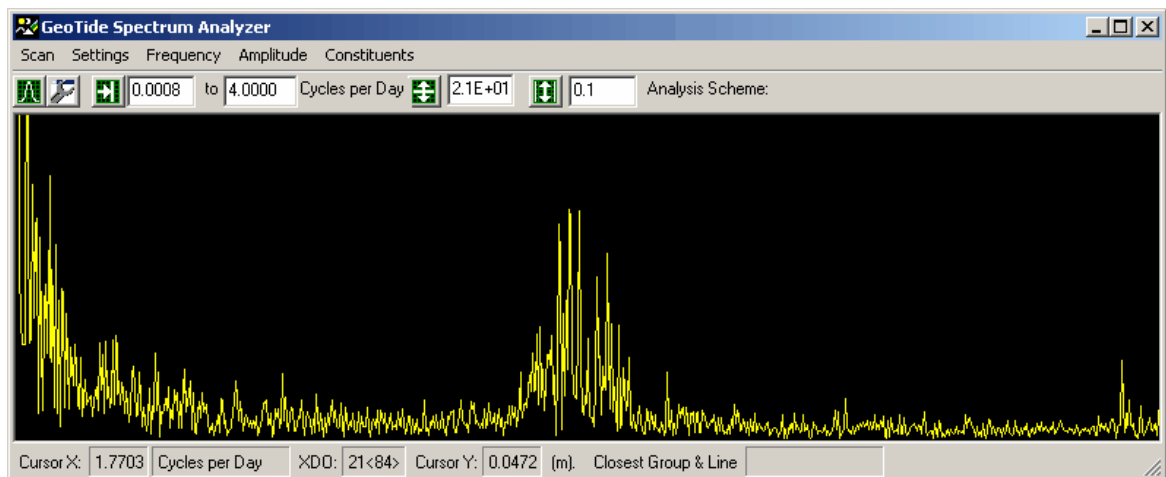
And of course, there is the point, harmonic analysis is based upon linear theory and struggles to predict frequencies which have been generated by non-linear effects in the ocean even if they originate initially from an astronomical origin.

GeoTide-Prism can be used in a number of different ways, helping to identify missing or superfluous tidal components, and helping to discriminate between weather induced tidal variations and true astronomical variations..

Its main operating features are:

- Graphic display of spectrum of the source data and the harmonic constituents in the analysis scheme currently loaded.
- Icons: At the upper edge are a number of icons which enable you to change the display scales and settings.
- Cursor: At the lower edge is a display of frequency, XDO, nearest line and nearest group.

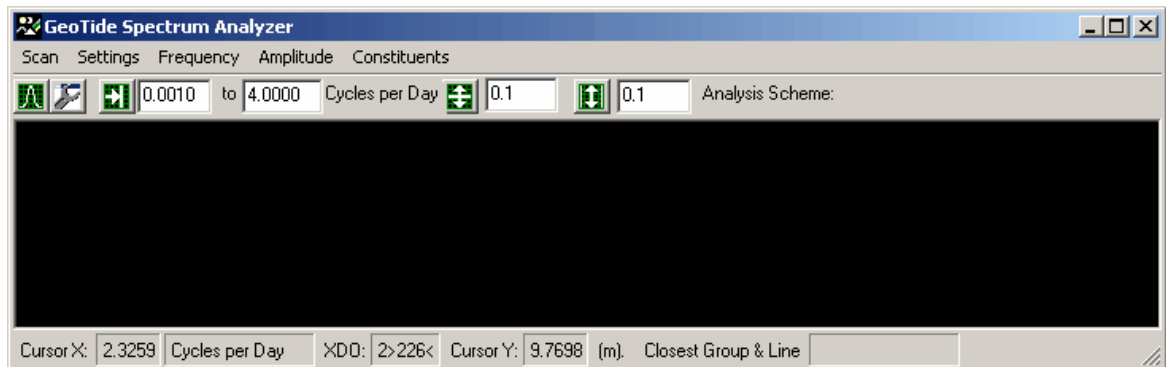
The window is re-sizeable and may be re-sized during its operation.



9.1 Functional Overview

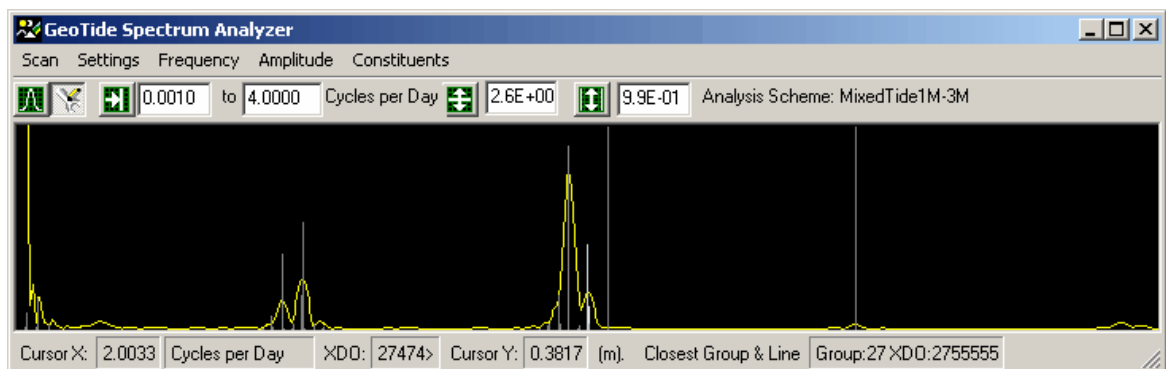


Clicking the Spectrum menu on the main screen top menu activates the **GeoTide Spectrum Analyzer**, initially with a blank display screen as shown below.



The screen consists of a resizable window, a top menu and a set of tool icons which (from left to right), start a scan, provide access to settings, set lower and upper scan frequencies, set the vertical scale of the graph, and set the vertical scale of the harmonic constituents (if present).

9.2 Tool Icons



The clickable icons functions are shown below. Once an icon is activated all the other clickable icons are disabled until the process is completed.



Creates the tidal power spectrum.



X Scale

Zooms in by changing lower and upper frequencies of the horizontal axis of the display. To zoom and change the x axis scaling, click the icon and then click and drag the mouse from the lower limit required to the upper limit required using the left mouse button. Click this icon again to complete the process. You can also change this value by entering text into the lower and upper frequency limit boxes to the right of the icon.



Y Scale

Changes the scale of the spectral plot. Click the icon and then drag the mouse cursor down the image to set the new scale required. Click the icon again to complete the process.



Harmonic Relative Y Scale

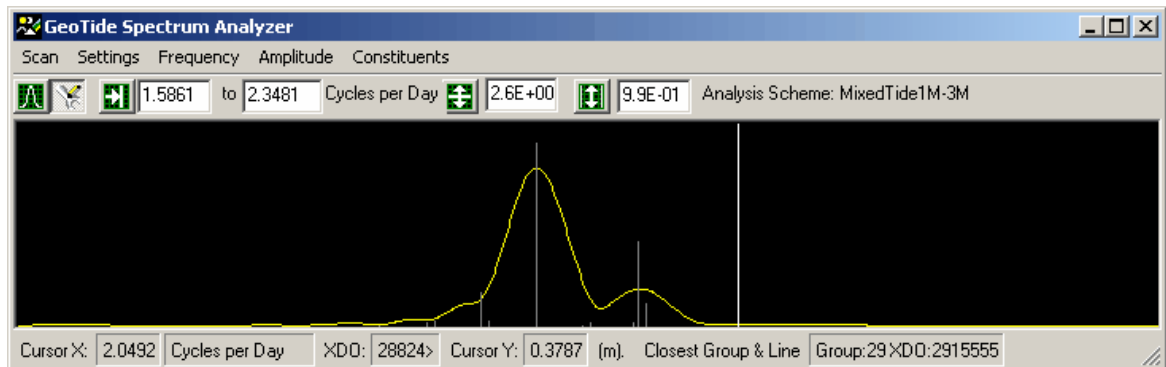
Changes the vertical scale of harmonic plot relative to the line plot. Click the icon and then drag the mouse cursor down the image to set the new scale required. Click the icon again to complete the scale change.



Settings

Click the icon to displays the settings screen so you can change the display behaviour, colours and set the anti-alias window function. Clicking again closes the settings screen

9.3 Missing Scheme Constituents



It is always possible that a tidal component is present in the data which was not anticipated. This may be suspected during tidal analysis, or when comparing predicted with observed data.

However identifying such a component without a spectral display is not easy, involving numerous trial and error with different tidal schemes.

Our Tidal Spectral Analyser can help you to determine the existence of such a component, ready for inclusion in a tidal scheme. Typically, the components could be due to an unexpected large shallow water component, or due to an unexpectedly large annual variation which may be influencing tidal range.

To establish if your source tidal scheme has missing components

1. On the settings window check the checkbox is set for display harmonic constituents,
2. Ensure the number of points is adequate and the frequency range is not too great (see resolution information)
3. Click the scan icon.

Visually compare the existence of peaks with the harmonic constituents. In the example above a harmonic constituent is present in the tidal scheme which is not present at all in the power spectrum. Using the Spectrum analyser this can immediately be seen since the vertical line on the right does not correspond with a peak in the tidal curve.

Hint: Move the cursor to the component peak to identify its frequency and Doodson number

Conversely, GeoTide-Tidal Analyser can be used to reassure you that all necessary components are indeed present.

9.4 Redundant Scheme Constituents

It is possible that a component may be present in a tidal scheme which is not present in the source tidal data. Removal of an unused component increases analysis speed and may also increase analysis accuracy due to the reduction in the number of unknowns.

The lack of a constituent in the display can be due to a number of reasons other than its non-existence. It is important to eliminate the possibilities below before concluding that a component does not exist in source data.

1. The source data record is of insufficient duration to resolve this constituent, and may have been masked by resolution effects. Remedies:
 - a. Review the issues raised in the section on resolution.
 - b. Use as long a duration as possible.
2. The number of points in the display setting within the Spectrum Analyser is insufficient. Remedies:
 - a. Change the lower and upper limits of the display to zoom in on the component in question.
 - b. Increase the number of points in the display setting window.

The above limitations do not apply generally to the tidal analysis process - only for the identification of the absence of a component within the spectral analysis.

It is always better to create a new scheme for a given location rather than to modifying an existing scheme file.

Before modifying any tidal scheme file you must be certain that you have considered all possible impacts on the analysis in every location in which the tidal scheme is applied.

Warning: Do not change tidal scheme files unless you have thoroughly understanding of the issues involved.

9.5 Sampling Issues

The Nyquist theorem tells us that the sampling rate must be greater than twice the highest frequency within an analogue signal in order to avoid a phenomena known as aliasing. Aliasing is the generation of artificial frequency components due to inadequate sampling. In tidal work the highest frequencies are encountered in tides with non-sinusoidal profiles. Frequently tidal overtones are invoked for the calculation of Shallow Water Components of up to 6 times per day. The user should ensure that the tidal source data is sampled sufficiently frequently in order to avoid aliasing, otherwise spectral components may appear in the display which do not actually exist.

9.6 Resolution Issues

Spectral analysis has an inherent resolution limit, which is dictated by the duration of the source tidal record. This resolution determines the discrimination between adjacent frequency channels, and the precision with which the frequency of a component can be measured.

As a general rule if the tidal duration of source data extends over n days, the resolution will be $1/n$ days. This is the half-width of the displayed line, the full width is twice this figure. Individual tidal frequency components having a frequency closer than this will not be resolved. Furthermore, it is entirely possible that such closely spaced harmonics are out of phase during the sampling period and effectively therefore cancel out - resulting in

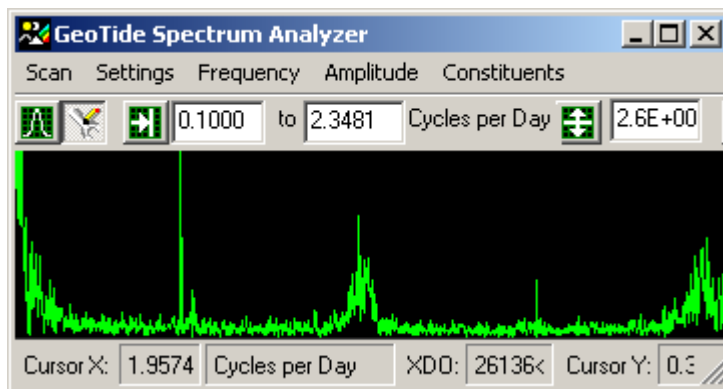
the non-appearance of either of the components on the spectral display.

The remedy is to always ensure that the duration covered by the source data is sufficient - this increases the resolution and will mean that such components are shown as separate peaks whether or not they are in or out of phase.

9.7 Meteorological Tides

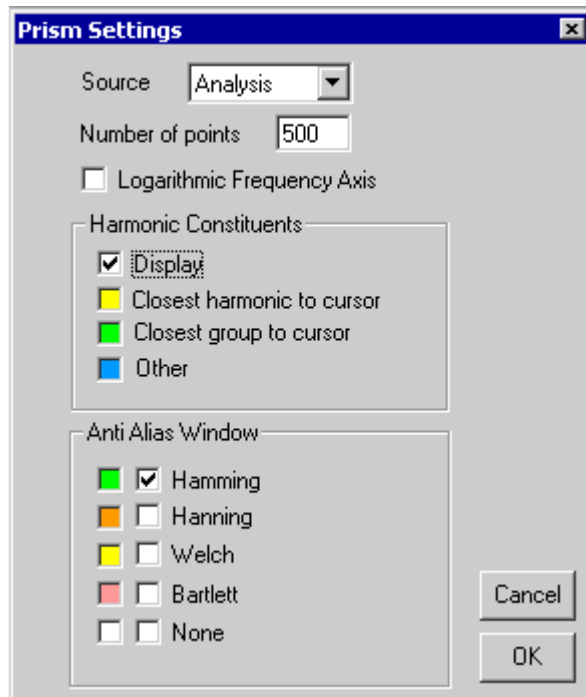
Tides of non-astronomical origin (e.g. drying of land, annual rainfall, melting of ice, seasonal winds, changes in air pressure) can have a greater effect than their equivalent astronomical components. Furthermore, while astronomical effects are entirely predictable, meteorological components are not. When meteorological induced components interact with astronomical constituents the resulting modulation has a considerable effect upon the line shape, broadening its base considerably.

In situations where many adjacent harmonic lines are affected by meteorological conditions the peaks consequently appear to stand upon a broader baseline shoulder of noise.



The screenshot shows the semi-diurnal tidal components standing upon a shoulder of meteorologically induced noise (annual flooding) from an 18 year tidal record in Galchipa, Bangladesh.

9.8 Display Settings - Parameters



Clicking the icon  displays the settings screen above so that you can change the display behaviour and colours below. The active features are:-

Source

Determines which plotting layer on the main screen is used for the spectral analysis. Original, Working, Analysis and Prediction. See Plot Controller.

Number of points

Sets the number of points used in the spectral display. You should ensure that the number of points being used is sufficient to display any peak, bearing in mind the frequency resolution.

Logarithmic Frequency

Converts the x axis to a logarithmic frequency axis

Display

Checkbox enables display of harmonic constituents of the analysis scheme

Closest Harmonic to Cursor

Sets the colour of the harmonic line which is closest to the mouse cursor

Closest Group to Cursor

Sets the colour of the harmonic group which is closest to the mouse cursor

Other

Sets the colour of all other non-highlighted lines and groups.

9.9 Display Settings - Data Windows

GeoTide Prism has a choice of built-in data windows (also known as spectral weighting functions). Please see the next page for a detailed discussion on the purpose of data windows. A number of data windows can be enabled on the settings screen, and the use of more than one data window at a time is fully supported for comparison purposes.

Click the appropriate checkbox to use the respective anti-leakage window in the spectrum analyzer or set the colour of the display by clicking the respective coloured square.

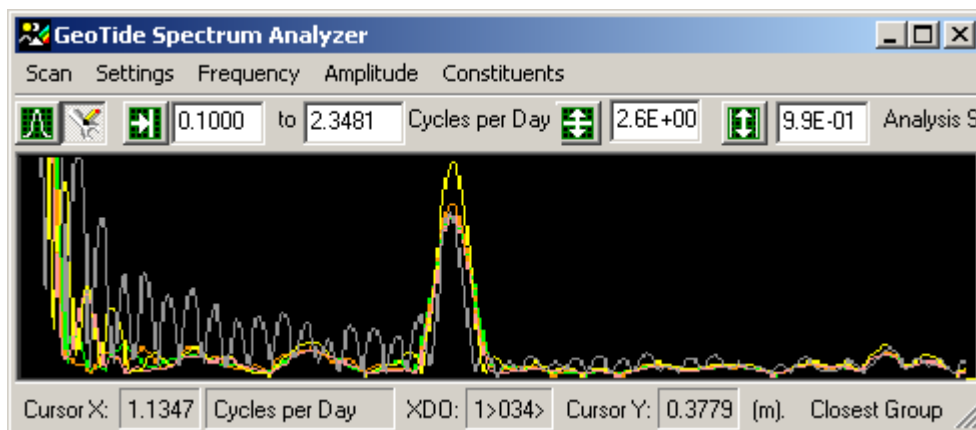
Window Method	Formula
Hamming	$0.54 + 0.46 \cos(2\pi i / N)$
Hanning	$0.5 + 0.5 \cos(2\pi i / N)$
Welch	$1 - ((i - N/2) / (N/2))^2$
Bartlett	$1 - 2i / N, 1 + 2i / N, 0$
None	0,1,0

9.10 More on Data Windows

Spectral analysis behaves as if the input data wraps around from beginning to end. i.e. it assumes a repetitive waveform of an exact whole number of cycles is being converted. When the waveform does not contain an exact number of cycles, the discontinuity generated by this implied wrapping process creates artefacts - i.e. frequency components appear which do not really exist. This process is also referred to as spectral leakage. These artefacts occur at frequencies having integral multiples of the inverse sample duration. Thus They always appear at the lower edge of the spectrum. This is an intrinsic consequence of any spectral analysis process.

The magnitude of the artefacts can be decreased by applying a data window to the input data. This reduces the size of the artefacts but the price paid is a loss in resolution.

GeoTide Prism has a choice of built-in data windows. These can be enabled on the settings screen, and the use of more than one data window at a time is fully supported for comparison purposes.

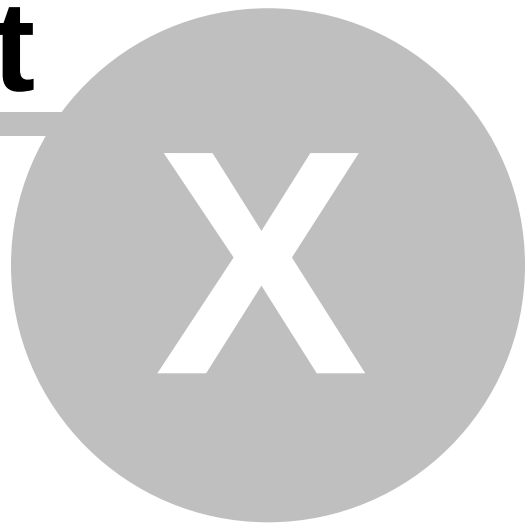


The screenshot shows the artefacts generated from an 18 year tidal record. Without a data window (grey) the series of generally decreasing artefacts are shown, whilst with data windows (other colours) the effects are considerably reduced. The peak shown at

0.0027 per day is an annual tidal component (probably of non-astronomical origin) which is clearly distinguishable from the artefacts.

Note: An alternative practical measure is to increase the duration of the sample, since this effectively shifts the leaked frequencies to a lower portion of the spectrum, and away from the frequency of interest.

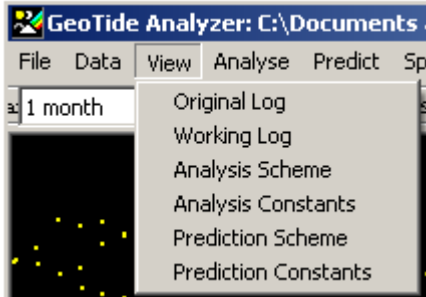
Part



Logs, Schemes & Constants

10 Logs, Schemes & Constants

A simple text viewer is included for viewing **Logs, Schemes & Constants**. The behaviour of the viewer window is the same whichever type of data you are examining. This section describes the use of the text viewer and what it displays.



The view menu causes the appropriate text viewer to be displayed.

As a text window, it can be closed by double clicking, and you can cut and paste data into the clipboard by right clicking. You can also display it or hide it by using the appropriate view menu. You cannot edit this data.

Log

A comprehensive log of actions is continuously taken while editing and analysis operations are undertaken. This enables an operator to rapidly locate problems and to find out how they were caused. The logs are embedded in the respective tidal record files. Logs for the original layer and working layer can be viewed.

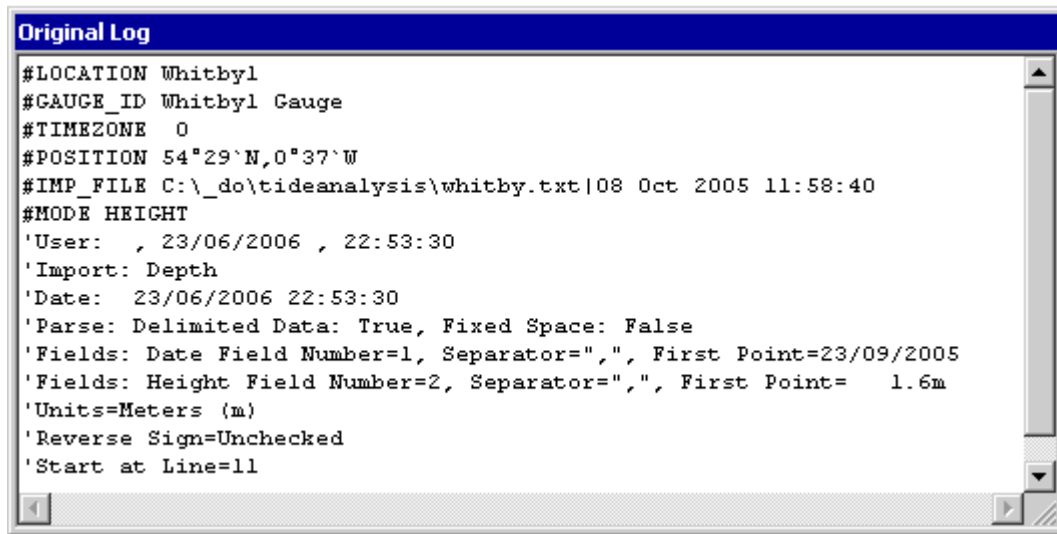
Schemes

Tidal Schemes consist of a list of tidal harmonics which are to be sought during the analysis process. Information is included regarding groups of tidal harmonics and the type of shallow water corrections which are to be used. A different scheme may be loaded for analysis or prediction so you can view these separately. You can view here the scheme associated with the analysis layer and the prediction layer.

Constants

Harmonic Constants are the products of the analysis process, and contain the amplitudes and phases for each tidal component (or group of components). A different set of constants may be loaded for analysis or prediction so you can view these separately.

10.1 Original Log



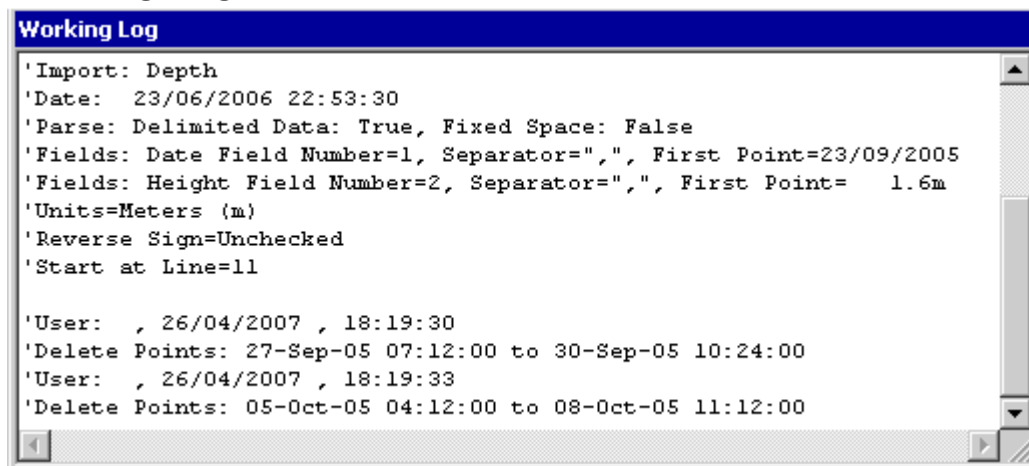
```
Original Log
#LOCATION Whitby1
#GAUGE_ID Whitby1 Gauge
#TIMEZONE 0
#POSITION 54°29'N,0°37'W
#IMP_FILE C:\_do\tideanalysis\whitby.txt|08 Oct 2005 11:58:40
#MODE HEIGHT
'User: , 23/06/2006 , 22:53:30
'Import: Depth
'Date: 23/06/2006 22:53:30
'Parse: Delimited Data: True, Fixed Space: False
'Fields: Date Field Number=1, Separator=",", First Point=23/09/2005
'Fields: Height Field Number=2, Separator=",", First Point= 1.6m
'Units=Meters (m)
'Reverse Sign=Unchecked
'Start at Line=11
```

The Original Log is text window (below) showing a complete history of those operations which have been carried out on the source tidal data (.rec) file which was loaded. It includes details of points which were removed, sampling and averaging actions, but not tidal analyses.

The lines starting with a single quote ' show the log information describing how the operation was carried out.

The lines starting with a '#' show internal information which is used by the system.

10.2 Working Log

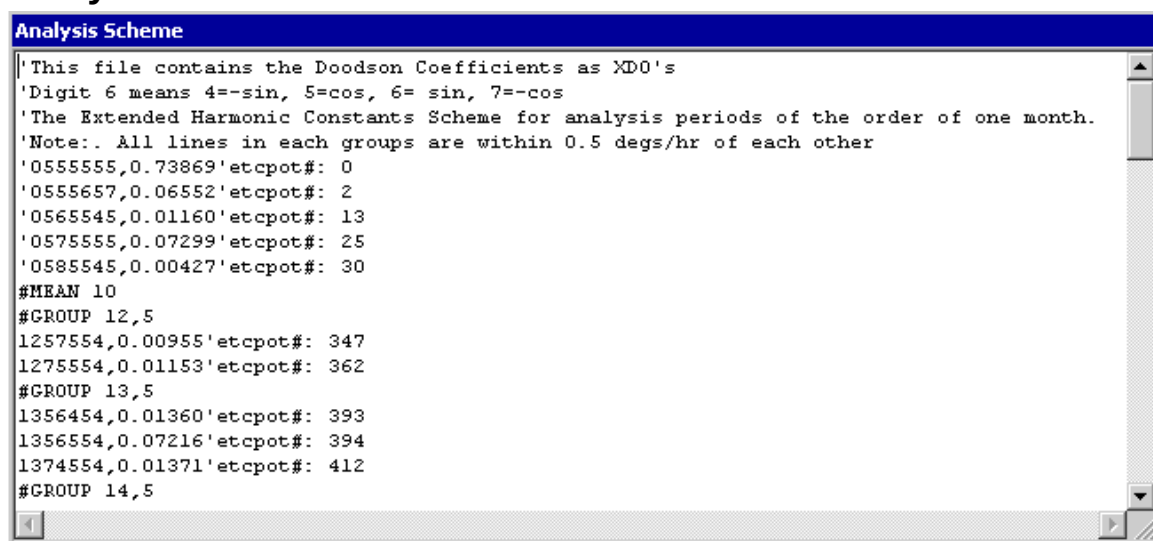


```
Working Log
'Import: Depth
'Date: 23/06/2006 22:53:30
'Parse: Delimited Data: True, Fixed Space: False
'Fields: Date Field Number=1, Separator=",", First Point=23/09/2005
'Fields: Height Field Number=2, Separator=",", First Point= 1.6m
'Units=Meters (m)
'Reverse Sign=Unchecked
'Start at Line=11

'User: , 26/04/2007 , 18:19:30
'Delete Points: 27-Sep-05 07:12:00 to 30-Sep-05 10:24:00
'User: , 26/04/2007 , 18:19:33
'Delete Points: 05-Oct-05 04:12:00 to 08-Oct-05 11:12:00
```

In addition to containing the details of the **Original Log**, the **Working Log** includes the additional operations such as deleting or sampling, which have been carried out during this session. When the tidal record is saved this information is embedded in the file so that it will appear within the original log in future.

10.3 Analysis Scheme



```

Analysis Scheme
|This file contains the Doodson Coefficients as XDO's
'Digit 6 means 4=-sin, 5=cos, 6= sin, 7=-cos
'The Extended Harmonic Constants Scheme for analysis periods of the order of one month.
'Note:.. All lines in each groups are within 0.5 degs/hr of each other
'0555555,0.73869'etcpot#: 0
'0555657,0.06552'etcpot#: 2
'0565545,0.01160'etcpot#: 13
'0575555,0.07299'etcpot#: 25
'0585545,0.00427'etcpot#: 30
#MEAN 10
#GROUP 12,5
1257554,0.00955'etcpot#: 347
1275554,0.01153'etcpot#: 362
#GROUP 13,5
1356454,0.01360'etcpot#: 393
1356554,0.07216'etcpot#: 394
1374554,0.01371'etcpot#: 412
#GROUP 14,5

```

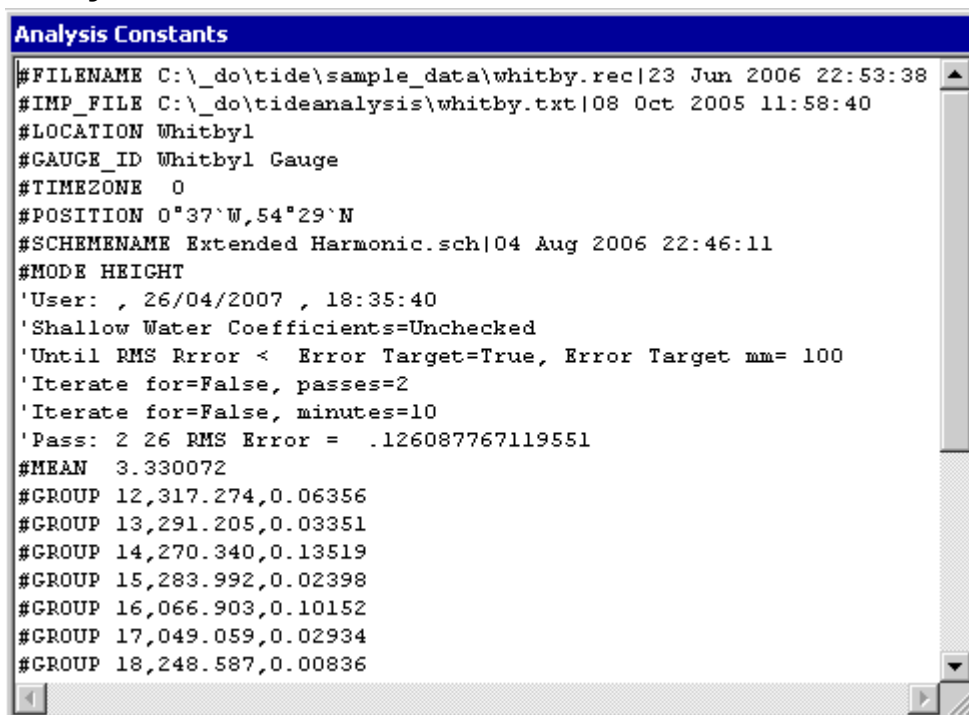
Shows the contents of the tidal analysis scheme file (*.sch) which is being used for Analysis (if loaded).

Lines beginning with a quote ' are comments which have been entered into the system when the scheme was prepared.

Lines beginning with '#' are group or component names.

Lines beginning with numbers are Doodson coefficients.

10.4 Analysis Constants



```

Analysis Constants
#FILENAME C:\_do\tide\sample_data\whitby.rec|23 Jun 2006 22:53:38
#IMP_FILE C:\_do\tideanalysis\whitby.txt|08 Oct 2005 11:58:40
#LOCATION Whitby1
#GAUGE_ID Whitby1 Gauge
#TIMEZONE 0
#POSITION 0°37'W,54°29'N
#SCHEMENAME Extended Harmonic.sch|04 Aug 2006 22:46:11
#MODE HEIGHT
'User: , 26/04/2007 , 18:35:40
'Shallow Water Coefficients=Unchecked
'Until RMS Error < Error Target=True, Error Target mm= 100
'Iterate for=False, passes=2
'Iterate for=False, minutes=10
'Pass: 2 26 RMS Error = .126087767119551
#MEAN 3.330072
#GROUP 12,317.274,0.06356
#GROUP 13,291.205,0.03351
#GROUP 14,270.340,0.13519
#GROUP 15,283.992,0.02398
#GROUP 16,066.903,0.10152
#GROUP 17,049.059,0.02934
#GROUP 18,248.587,0.00836

```

Shows the tidal harmonic constants which have been created by the tidal harmonic analysis during this session.

Lines beginning with a '#' are variables which are required by the internal system.

Lines beginning with a ' are the settings on the analysis screen when the analysis was carried out.

Lines beginning with #GROUP show the name phase (in degrees), and amplitude and of each group.

10.5 Prediction Scheme

This menu option causes the Prediction Scheme to be displayed in the text viewer, similar to the Analysis Scheme. The Prediction Scheme is the scheme which is used to create a Prediction layer (if loaded).

10.6 Prediction Constants

This menu option causes the Prediction Constants to be displayed in the text viewer, similar to the Analysis Constants. The Prediction Constants are the harmonic constants which are used to create a Prediction layer (if loaded).

Part



XI

Creating a 2D Stream

11 Creating a 2D Stream

A two dimensional tidal stream prediction can be created using GeoTide Analyzer by using two sets of orthogonal components (i.e. components at right angles). We assume here the source data consists of speed heading and date-time. The steps are:-

1. Import the source data using the 2D Stream import option described in the Importing Data section. Set the direction at 000° to resolve the component to a Northerly direction.
2. Process the same source data using the 2D Stream option but set the direction to 090° to resolve the component to an Easterly direction. When processing the same file again you will notice that the various meta-data boxes are pre-filled to save you re-entering the data. Note:
3. Create the tidal harmonic constants for each 1 dimensional set of data.
4. Combine the two sets of one dimensional location constants into a (*.tc2) file. This can then be input into GeoTide Predictor for creating predictions of 2D Streams.

The following section describes how to combine the two sets of constants representing orthogonal components.

* You could use any other directions provided they subtend an angle of 90 degrees. This may be preferable if the stream is not running in an open ocean and is constricted to run in a straight or channel.

11.1 Merging 1D streams

Click the File>Create 2D Stream on the main screen to activate this facility.

This screen is used for combining two sets of location constants, each representing orthogonal (right angle) components of the same stream. Click the left and right hand file text boxes to load the two location constants file. These files have file extension (*.tc1). The system attempts to combine the two sets of data, and it checks for any incompatibility in the data. During this process GeoTide Analyzer renames the tidal constants files corresponding to the streams having file extension ".tc1" to ".tsc" and it creates a new file with file extension ".ts2" which contains information about the tidal stream components.

Note: Warnings are produced when the following data do not match between the files:-

- location

- scheme
- position
- import file
- mode

Terminating Errors occur when

- Data was not imported as a stream
- The component directions are not at right angles

The program also informs the operator when the two sets of data have been successfully merged into a (*.tc2) file.

Part

XII

**Harmonic Tidal
Theory**

12 Harmonic Tidal Theory

Tidal harmonic theory explains that the astronomical tidal height anywhere in the world can be represented by the sum of a set of tidal frequency components, called tidal harmonic constituents.

Although tidal theory provides the frequency of these harmonic constituents, it does not provide - for a given location - the amplitude or phase of these components. The amplitude and phase of these components can only be theoretically calculated for a spherical frictionless earth with no land masses. The variously shaped land masses and sea floor has a complex effect upon water flow which currently is not amenable to computer modeling. Therefore the amplitude and phases of each component must be calculated empirically from observed data..

Tidal Analysis calculates the amplitude and phase of each known harmonic frequency component by an empirical process of trial and error called iteration. The set of amplitudes and phases which are determined by the analysis for a given location are called the tidal Harmonic Location Constants.

12.1 Tidal Schemes

The list of tidal harmonic components sought during a tidal harmonic analysis is called a Tidal Scheme or Tidal Schedule.

You can think of the Tidal Scheme as being a general template, while the Harmonic Location Constants are the particular fingerprint for a given location.

Sometimes the Tidal Harmonic Constituents are grouped together in order to reduce the number of unknown quantities within the mathematics. This is an approximation which can considerably reduce the computational effort required, and can actually increase the accuracy for a given computer effort. The tidal scheme also includes information on these groupings.

Complex tidal curves may also require the inclusion of harmonics of the tidal constituents. These harmonics are also listed within the Tidal Scheme.

Note

For the analysis of tides, tidal Harmonic Analysis is much more efficient than its more general relation Fourier Analysis. In Harmonic Analysis, the frequency of each component is already known whereas in Fourier Analysis the frequencies are not known. In either system neither the amplitude or phase of the components are known. Tidal Spectral Analysis uses Fourier Analysis and is useful for searching for unexpected tidal components, while tidal Harmonic Analysis is used for searching for known components.

12.2 Tidal Groups

Unfortunately, some of the harmonic components being sought may have very similar frequencies, and therefore a considerable period of time (sometimes years) is required before these components manifest themselves by going in and out of phase with each other. If the tidal source data does not extend over this period of time, the analysis process cannot resolve the amplitude and phase of each component.

Although tidal theory cannot give the absolute amplitude and phase at a given location, it can fortunately give the relative amplitude and phase of the nearby components, provided the frequencies are sufficiently close together. In such cases, an approximation can be made, by grouping those components with a similar frequency into a single

component called a tidal group.

By grouping such similar frequency components, the tidal analysis has only to determine a single amplitude and phase, rather than the amplitude and phase for each component within the group. Therefore tidal grouping enables the tidal hydrographer to use source data which extends over a considerably shorter time - compared with tidal analysis without grouping.

GeoTide Analyzer supports the use of tidal groups within its tidal scheme files, as well as individual harmonic constituents.

12.3 Shallow Water Coefficients

Normal tidal theory is based upon the concept of linearity, which assumes that the astronomical tide can be represented as a simple sum of each individual frequency component.

However in some locations, especially those with extra-tides or standing tides, components of higher frequencies are generated, not directly from the gravitational tidal potential arising from the sun and moon, but by non-linear generation of harmonic overtones within the ocean. In addition to the simple overtones, harmonics and sum and difference frequencies of frequency components are also created. Such non-linear effects mainly occur in shallow waters and so historically are called shallow water overtones, extra tides or standing tides.

Corrections for this non-linear effect are implemented in two main ways, by using either harmonic overtones or by using shallow water corrections.

Harmonic Overtones

Astronomical tidal theory can fortunately be used to provide the frequency of the overtones and of the sum and difference frequencies. Consequently a simple extension of the tidal scheme to include these additional frequencies can be used to account for the shallow water effects. These are known as the Shallow Water Constituents. They are calculated for each individual overtone..

Shallow Water Correction

This method avoids the calculation of the individual overtones by assuming that the corrections will arise mainly from the (usually) larger semi-diurnal tide. It calculates those amplitudes and phases for the second overtone (at 4 times per day) and third overtones (at 6 times per day). These F4 and F6 components are used by the UKHO in the Admiralty Simplified Scheme.

Analyzer supports both the harmonic overtone scheme and the shallow water correction method. Clicking the checkbox labelled SWC enables the Admiralty Simplified Scheme (Shallow Water Correction Scheme) used by the UKHO, while leaving the box unchecked uses the Harmonic Overtone method (provided the overtones are listed within the scheme file).

12.4 More on Schemes

There are over 10,000 known tidal components and it is impractical to include them all within a tidal scheme even if they are grouped. A tidal scheme with too many components will actually be less accurate (due to the increasing number of unknowns) and will be slow. However tidal schemes which do not have a sufficient number of components will not be universally applicable. As usual a compromise is required, it being advantageous to use a number of different schemes, according to the duration of

the tidal source data available and the complexity of the tidal curve.

Source Data Duration

As a general rule if the tidal duration extends over n days, individual tidal frequency components which have a frequency closer than $1/n$ days will not be resolved. Therefore such components, which are closely spaced in frequency, should be included as members of a group rather than individually. therefore the tidal scheme chosen is related to the duration of the tidal source data.

Tidal Curve Complexity

Simple tidal curves, having a substantially sinusoidal shape, require the inclusion of only the fundamental tidal components. Tidal curves having a non-sinusoidal shape require the additional inclusion of overtone, sum and difference components, which may slow analysis. Curves having substantial symmetry but a flattening at the top and bottom require the application of even harmonics of the fundamentals. Tidal curves which are triangular in shape, i.e. sharp at the top and bottom require odd harmonics. Those which lack symmetry may require both even and odd harmonics. These can be odd or even harmonics can be incorporated within the Tidal Scheme files as desired.

12.5 Meteorological Effects

Conventional tidal theory assumes that the frequency components of the tide arise only from the action of the tidal gravitational potential i.e. pull of the sun and moon. It is the effect of this tidal gravitational potential which is termed the astronomical tide.

In some locations, in addition to the usual astronomical tide there may also be a sizeable meteorological tide.

A meteorological tide arises from meteorological effects, such as the seasonal drying of land, seasonal rainfall, summer melting of winter ice, seasonal winds, changes in air pressure or even annual changes in salinity. In some locations, the meteorological components can have a significant or even greater affect than the purely astronomical components. Furthermore, since the meteorological tide is derived from the weather, it has inherent statistical fluctuations, while the astronomical tide being derived from the motion of the sun, earth and moon, is always precisely predictable. In some extreme cases, the seasonal changes may affect not just the mean level but also the daily tidal range.

During tidal analysis, the meteorological tide can be mistakenly attributed to the astronomical tidal components. For example, annual changes in level can be attributed to the annual astronomical component (of frequency once per year) while annual changes in range can be attributed to two or more closely spaced astronomical harmonic components within the daily and semi-diurnal astronomical tidal groups.

The use of astronomical components to account for such meteorological effects can never lead to precise predictions. Furthermore, if tidal groups are being used, the tidal analysis assumes that the relative amplitude and phase of the components within a group are fixed. If some components of that group have an amplitude and phase primarily dictated by meteorological conditions, while others are dictated the tidal gravitational potential, the assumption that the relative amplitudes and phases hold across a group is no longer valid.

Therefore where large annual meteorological effects are present, the use of groups is discouraged.

12.6 Statistical Accuracy

There are any number of statistical measure of accuracy between an observed data set and a predicted data set which can be used. The definitions of the those used within GeoTide - standard deviation / RMS Error / Quadratic Mean and Mean Error are listed below.

RMS Error

This is also known as the standard deviation or quadratic mean. It is defined as

$$\sigma = \sqrt{(\sum (y_i - y_i')^2) / n}$$

where the summation $\sum$ is over $i = 1$ to n points

σ is the RMS Error
 y_i is the observed value of the i 'th source point
 y_i' is the predicted value of the i 'th point
 n is the number of points

Mean Error

Also known as the average error, and is defined by

$$\sigma = (1/n) \cdot \sum |y_i - y_i'|$$

where the summation $\sum$ is over $i = 1$ to n points

σ is the Mean Error
 y_i is the observed value of the i 'th source point
 y_i' is the predicted value of the i 'th point
 n is the number of points.

Index

- A -

alias 90
 aliasing 87
 analyse 13, 20, 59, 62
 analysing 10, 13, 16, 20, 24
 analysis 20, 24, 56, 57, 59, 61, 62
 analysis methods 57
 antialias 90
 anti-alias 89, 90
 ASCII 13, 36
 astronomic 13
 astronomical 17, 88
 astronomy 106
 Audience 8
 audit 94
 automated 22, 50
 automatic 10, 22, 50
 average 22, 49
 averaging 10, 20, 49
 axis 20

- B -

back 52
 bad 48
 bartlett 90
 bearing 100
 beginning 9
 block 50

- C -

cancel 52, 59
 capabilities 8
 center 20
 clipboard 73
 close 26
 closing 26
 coefficients 61
 Color 32

Colour 32
 colours 89
 column 13
 comma 36
 comma separated 13
 comparing 17, 24, 66, 67, 70, 71, 72
 Comparison 24
 component 84, 85
 components 84, 100, 104, 105
 concatenate 80
 configure 21
 configuring 21
 constituents 84
 constants 13, 16, 23, 24, 56, 59, 61, 63, 94, 96, 97
 constituent 85, 86, 87
 constituents 56, 96, 97, 104, 105
 contents 25
 continuous 56
 control 20
 controller 23
 converting 56
 copy 73
 corrections 105
 create 73
 CSV 36
 cursor 20, 52
 curve 20

- D -

data 13, 15, 36, 37, 40, 48, 50, 80, 84, 90, 95
 data window 89
 date 44
 default 10
 delete 15, 28, 48
 deleting 28, 29, 48
 delimited 36
 delimiter 44
 depth 37
 difference 67, 70, 71, 105
 directory 10, 63
 discrepancies 17
 discrepancy 17, 48, 67, 70, 71
 discrepant 22
 discrimination 87
 display 20

displayed 20
 displaying 10, 20, 95
 displays 10, 20, 31, 95
 distributing 79
 Doodson 104
 duration 56, 68

- E -

edit 15, 20, 22, 48
 editing 13, 22, 29, 52
 encryption 76, 79
 erroneous 56
 error 24, 48, 60, 66, 67, 70, 71, 107
 Exceed 81
 Exceedance 81
 Exceeding 81
 exit 20, 21, 26
 exiting 26
 export 21
 exporting 21

- F -

facilities 8, 27, 105
 FastDraw 32
 features 8, 105
 file 20, 59
 filter 22
 filtering 10
 find 25
 finding data 31
 fixed 44
 flood 106
 flooding 88
 flow 40, 43, 100
 folder 63
 folders 10
 Format 80
 fourier 24, 84, 85, 104
 frequency 84, 87

- G -

gaps 56
 Gauge 36, 37, 43, 71, 76, 80

getting started 9
 glitch 50
 glitches 28
 graph 20, 31, 68, 84, 95
 graphs 20
 group 56, 104
 groups 104

- H -

halt 59
 hamming 90
 hanning 90
 Harbour 81
 harmonic 13, 16, 24, 56, 57, 59, 61, 63, 84, 86, 87, 94, 96, 97, 104
 harmonic analysis 57
 harmonic constants 79
 HAT 17, 24, 72
 heading 43, 44, 100
 height 37
 help 20, 25
 High Tides 81
 highest 17
 horizontal 20
 how to 13
 how to make a spectrum 18

- I -

icons 84
 ID 76
 identifying 17, 50
 Import 21, 37, 41, 80
 importing 13, 21, 36
 incorrect 22
 index 25
 inerface 27
 interval 72
 intervals 67, 68, 70, 71
 inversion 57
 iteration 57, 59, 62
 iteration options 59

- K -

keys 27

- L -

land 104

LAT 17, 24, 72

latitude 76

layers 20, 23, 31

legend 23

level 17

Line 32

listing in Predictor 10

load 21, 59

loading 13, 15, 21, 71

location 56, 63

log 23, 95

Logalevel 80

logs 94

longitude 76

lowest 17

lunitidal 72

Lunitidal Interval 24

- M -

M2 72

main 20

manual 22, 52

manually 52

matrix 57

matrix inversion 57

md5 79

mean 17, 107

melting 88

menu 20

menus 20

merge 80

meter 43

MHWN 17, 24, 72

MHWS 17, 24, 72

missing 86, 87

ML 17, 24, 72

MLWN 17, 24, 72

MLWS 17, 24, 72

mouse 52

- N -

nonlinear 105

number 31

- O -

observed 66, 71, 95

operating 27

options 8

origin 20

original 20, 95

orthogonal 100

overtones 105

Overview 8

- P -

Parameters 24

pass 60

passes 60

perpendicular 100

plot 20, 31, 84, 89

plotting 20, 89

Point 20, 32

points 15, 28, 31

port details 76

position 76

power 24, 84

power spectrum 18, 85

predict 20

predicted 56, 66, 71

predicting 10, 17, 20, 24

prediction 13, 20, 66, 97

previous 53, 59

printing 73

processor 70

Purpose 8

- Q -

quitting 26

- R -

raw 36
 read 21
 Readership 8
 reading 21
 readout 20
 record 20, 56
 records 31
 reducing 48
 regular 56, 67, 68, 70, 71
 remove 15, 48
 removing 28, 50
 report 13, 17, 20, 24, 63, 70, 73
 reporting 13, 70
 resizing 30
 resolution 87, 89
 revert 53
 rms 66, 67, 70, 71, 107
 rogue 22, 48, 50, 56
 RTF 24, 70
 running 9

- S -

sample 22
 sampling 10, 20, 48, 87
 save 21, 63, 73
 saving 13, 15, 21, 73
 scale 20, 29, 84
 scan 24, 84
 scheme 13, 23, 56, 59, 86, 87, 96, 97
 schemes 94, 104
 Scope 8
 screen 20
 scroll 20, 27, 31
 searching data point 31
 seasonal 88
 selecting 48
 setting 84
 settings 21
 shallow 61, 105
 shortcut 27
 sizing 30
 smoothing 49

source 84
 spectral 24, 84
 spectrum 24, 84
 speed 43, 44, 100
 spikes 28
 SRD 80
 standard 66, 107
 Standard Deviation 24
 Standard Error 24
 starting 9
 statistic 107
 Statistics 17, 24
 steps 13, 18, 41
 stop 59
 storm 106
 stream 40, 41, 43, 100
 sub-sampling 48
 sufficient 56
 sum 105
 summer 88
 surge 106

- T -

target 60
 text 94
 Thickness 32
 tidal 13, 15, 20, 24, 59, 62, 100, 104
 tidal analysis 16
 tidal parameters 17
 tidal spectrum 18
 tide 37, 80, 100, 104
 tides 13
 time 60
 timescale 20
 timezone 76
 tools 76, 84
 trial and error 59

- U -

undo 52
 units 29
 user 27, 95
 using 9, 27

- V -

vector 43, 100
version 25
view 20, 94
viewer 63, 94
viewing 23, 31

- W -

water 61, 105
weather 88, 106
welch 90
Width 32
window 90
windows 10
winter 88
Word 17, 24, 70
word processor 17
working 20, 56, 95
worst 17
write 21
writing 21

- Z -

zoom 31, 84

